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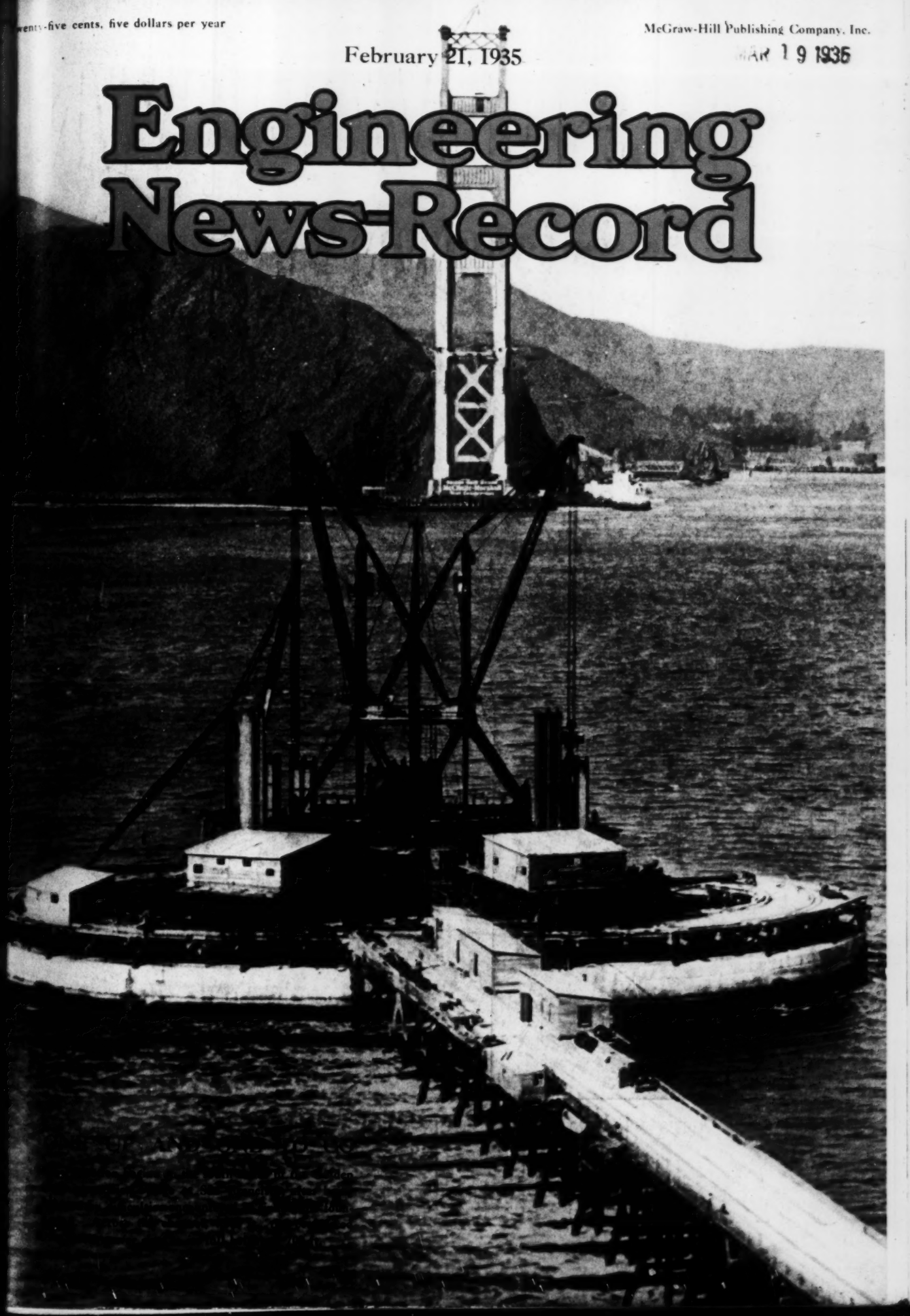

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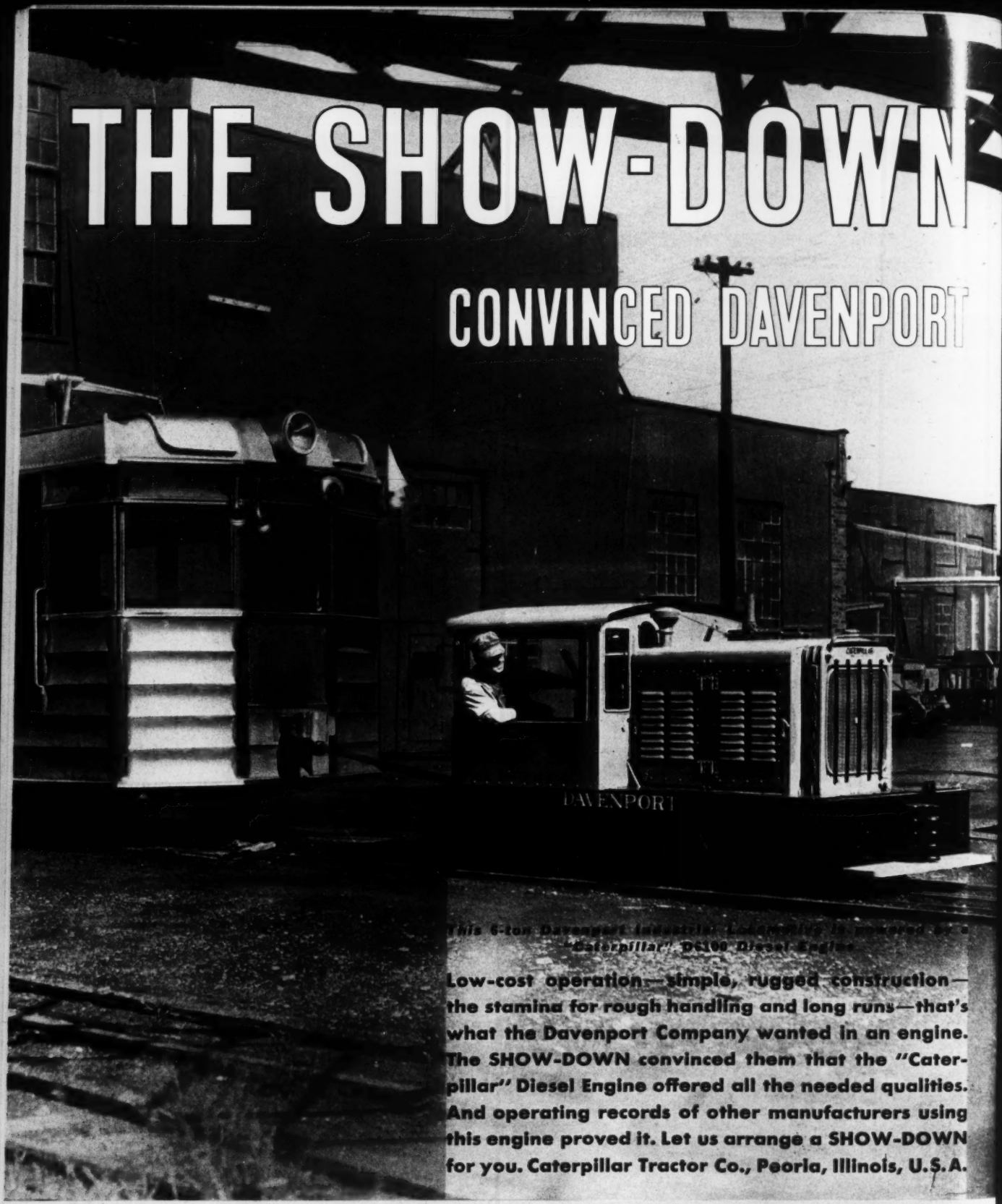

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All in the Same Boat

MORE and more the march of events drives home the need for greater unity in the construction industry. To its disunity it owes its basic weaknesses and some of its most harassing difficulties. Only as it becomes more completely integrated in purpose and action can each of its elements make real headway toward its own objectives.

It would be vain for the civil engineers or architects to concentrate on their intra-professional concerns and ignore the troubles of the industry through which alone they must market their services. It would be futile for contractors or sub-contractors to grapple with bid-peddling and other chiseling devices without the co-operation of those with whom they must do business as buyers or sellers. Manufacturers and distributors of materials or equipment will make satisfactory progress in trade practice enforcement only as conditions within and without the industry make for its general health.

To cite but one example, none of these could prosper under a nationalization of the construction industry such as might result from a policy of wholesale day-labor on public construction. Under the blight of such a political organization the professional and contracting groups would suffer a disheartening setback in their struggle toward recovery; under a regime of price-alone-buying, such as might be expected under that policy, a heavy handicap would be imposed upon those who offer quality services and quality products.

Thus it becomes clear that any effective conquest of both the internal and the external problems of the industry must be achieved through coordinated attack by a unified industry. To proceed on a piecemeal basis, each group concerned only with its own welfare, is to invite general defeat. United, the numerous and influential groups that compose this vast industry can wield an incalculable influence; disunited, they spend their individual energies and influence in wasteful dispersion.

If the engineers, architects and contractors are to foster construction volume and a reasonably stable demand for their services the industry must deal with certain fundamental conditions that are beyond the scope of any one of them alone. The function of capital investment and the related processes of construction financing must be conducted more soundly than they have been heretofore. The general public, the press and business generally must be educated to a better understanding of construction economics and a more intelligent attitude toward the appraisal and purchase of construction services. More rational relationships between construction costs and other price levels must prevail. The recurring specter of governmental competition with the industry must be banished. These and many other conditions call insistently for the consideration, cooperation and influence of a united industry.

The manufacturers and distributors of materials and equipment also are vitally concerned. If they would enjoy a reasonably stable demand for their products they must help the engineers, architects and contractors to achieve stability. So long as the industry is subject to the excessive fluctuations and the resultant uncertainties that have prevailed hitherto, it will continue in its role as either prince or pauper, to the devastating cost of all who are dependent on it.

Today conditions are ripening for a resumption of capital investment. Continued improvement in many lines is paving the way for new enterprise. Growing stability of values will attract more and more investors into the market. All this spells new opportunities.

But meanwhile the industry itself must prepare to make the most of those opportunities. It must clean up its internal abuses and destructive practices, ward off any threats of injudicious legislation, consolidate its influence in behalf of investment practice that will stabilize demand for its services rather than promote the speculative fluctuations of the past.

If the industry is to do this job it must have the ungrudging support and participation of each of its elements. Civil engineers and architects, contractors and subcontractors, manufacturers and distributors of materials and equipment, whether professional, industrial or trade, all are in the same boat. The welfare of each depends on the welfare of all. No one of them can do very much lasting good for itself unless now it is willing to contribute its best in behalf of the industry as a whole.

Willard Chevalier

ENGINEERING NEWS-RECORD

Published every Thursday. Vol. 114, No. 8. Price 25c. per copy. Subscription, domestic, Mexico, Central and South American countries, $5 per year. Canada, including duty, $7.50. All other countries, $9 a year or 36 shillings. Entered as second-class matter April 11, 1917, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U.S.A. Cable Address "McGrawhill, New York." Member A.B.P. Member A.B.C. Copyright 1935 by

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d Street, New York; 520 North Michigan Avenue, Chicago; 883 Mission Street, San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.

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In the News:

WORK ON THE SAN JACINTO TUNNEL on the Colorado River Aqueduct has been taken over by construction forces of the Metropolitan Water District, according to reports, and the crews of the contractor were ousted.

BY A UNANIMOUS VOTE the Ohio Engineering Society has affiliated itself with the National Society of Professional Engineers, making the eighth state group to join the national body.

BIDDING $803,989 on pier construction for the remaining channel crossings of the Triborough Bridge project, the Frederick Snare Corp. was low among seven firms.

CONSTRUCTION actually started on the first all-federal, PWA-financed, low-cost housing project with the ground-breaking ceremonies for the Techwood development in Atlanta.

EMPLOYMENT on the Grand Coulee Dam project has reached 2,690, exclusive of about 150 in the engineering force of the Bureau of Reclamation.

A LOAN AND GRANT OF $1,108,000 has has been made from the remaining PWA funds to the Greybull Valley Irrigation District in Wyoming for improvement, including a diversion dam and main canal.

THE CHAMBER OF COMMERCE OF THE UNITED STATES, through a published report of its finance committee, is advocating a reduction of $2,000,000,000 in the Administration's work-relief program.

In This Issue:

BRIDGE CONSTRUCTION OPERATIONS continue to depart from conventional methods, and the present article describes another job on which fixed derricks were used for building a high concrete arch on the Calvert St. crossing of Rock Creek in Washington, D. C.

GEOPHYSICAL SURVEY METHODS have been used for preliminary explorations at dam sites and along tunnel lines, and now the Minnesota highway department has developed the procedure to prospect for sand and gravel deposits for road metal.

CONSTRUCTION OF FLOORS with asphalt-emulsion mixtures has always involved setting problems resulting from slow evaporation. Experiments are described which investigated variations in an effort to minimize this difficulty.

PART II OF THE ARTICLE reviewing experience in deep and novel caisson sinking on the San Francisco-Oakland Bridge covers in detail the problems encountered at each of the individual piers. Final judgment as to the relative advantage of domed and false-bottom design for open-caisson work is given.

EXPERIMENTS with prestressed concrete pipe have been carried out with significant results at Purdue University. By prestressing the reinforcing steel, the initial compressive stress in the concrete is increased to such an extent that a hydrostatic-pressure stress cannot overcome it and convert it to tension.

PAVEMENT SIGNS may be made more visible if painted on a black background of asphalt, according to the experience of a St. Louis suburb.

A SECOND INSTALLMENT of abstracts made from foreign-language periodicals of important articles on activities in research, design and construction is published in this issue.

ELUTRIATION of digested sludge prior to dewatering it by vacuum filtration is desirable, according to Baltimore experiments. By using a sludge-water ratio of 1:7 or 8, the price per ton for dewatering can be materially reduced, it is estimated.

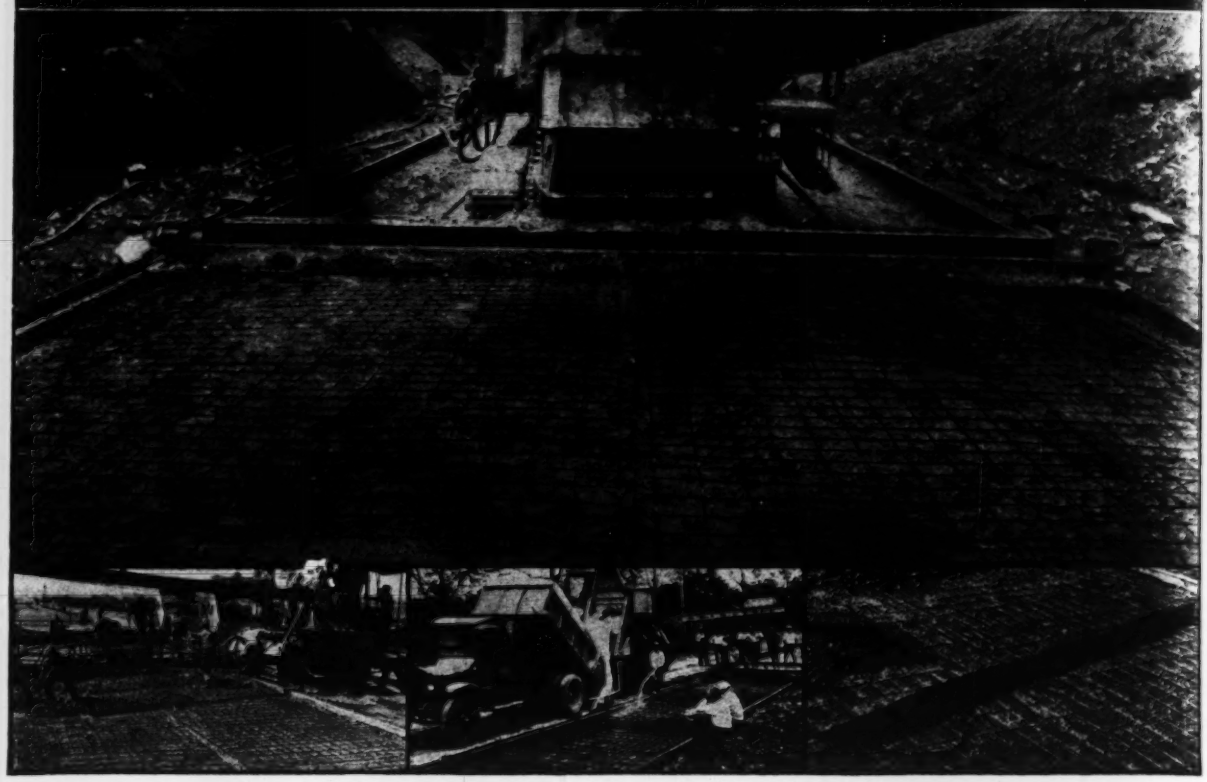
NOTABLE NEW DATA on joint-filler and cushion-course materials were reported to the recent convention of the National Paving Brick Association. Research results and field experience with de-aired brick were also recorded.

CANADIAN ENGINEERS, like engineers in this country, have had to interest themselves in many broad public questions during the past few years. The effect of this was reflected n the recent meeting of the Engineernig .nstitute of Canada, where Dominion affairs overshadowed local and detailed technical matters.

Coming Articles:

PROTECTING THE CHANNEL below a dam against scour is one of the perennial problems of engineers who design dams. In a coming article, engineers of the U. S. Bureau of Reclamation review past practice and set forth the controlling factors to be considered in developing a rational spillway design.

POSITIVE CRACK CONTROL



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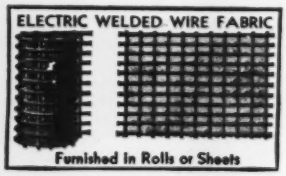

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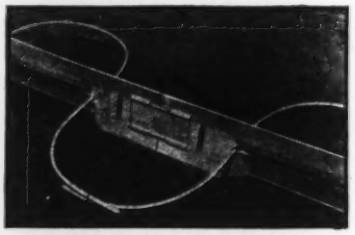

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February 21, 1935

FIG. 1—PROSPECTING TRUCK contains all instruments and tools for geophysical survey. A cable length of 200 ft. gives operator on truck a range of about 5 acres.

Prospecting for Road Metals by Geophysics

General method of geophysical surveys successfully used by the Minnesota highway department for locating subsurface sand and gravel deposits for road construction

By Stanley W. Wilcox

Geophysical Engineer, Minnesota Department of Highways, St. Paul, Minn.

THE BUSINESS of examining the crust of the earth for new supplies of useful substances is an uncertain one. For centuries man depended on the little subsurface evidence that could be seen beneath his feet. As the demands for stored earth materials increased, man pooled his observations and developed theories about the probable origin and occurrence of oil, minerals or rocks and founded the science of geology, the practical application of which represented a great advance over random exploration. The geologist, however, is also dependent on surface observations or rock exposures, and on what subsurface data he can acquire from well records. Something is needed to bridge the gap between the generalized theories of the geologist and highly specific and localized information of useful minerals, and the answer these days seems to be geophysics.

Basic principles

Geophysical prospecting is a relatively new application of science to the study of the earth's crust. If a small portion of crust is examined, as for instance a specimen of limestone, a common rock, the physical properties most obvious to the eye are color and shape. There are others none the less real that the specimen possesses such as density, electrical conductivity, magnetic susceptibility, elasticity, temperature and radioactive content, all properties capable of quite exact laboratory measurements, and what is more important from the present viewpoint, *they are capable of detection at a distance.*

For example, the mass of any buried section in the earth's interior contributes its part to the total gravitational field at any point on the surface; in similar manner the magnetic field is made up of the contributions from all the magnetic bodies within the earth. The passage of an electric current through the ground distributes itself according to well-known physical laws—the flow pattern being determined by the conductivity and the position of the component parts within the conducting media. The propagation of sound energy behaves in a like manner, with elasticity the controlling factor. Heat has well-known distance effects, while radioactive substances shoot out forms of energy capable of detection some distance from their source.

It is not within the scope of this article to do more than point out this variety of geophysical methods. Its purpose is to elaborate on one method (the electrical), whose possibilities for earth-material classification in general and for sand and gravel prospecting in particular should interest civil engineers and contractors.

Electrical prospecting

The electrical properties of minerals, rocks and soils vary greatly, especially in their ability to conduct an electrical current. The conductivity of rock salt and metallic silver, both substances found in nature, differ by ten to the twentieth power (ten followed by twenty zeros). This is an extreme case to be sure, but

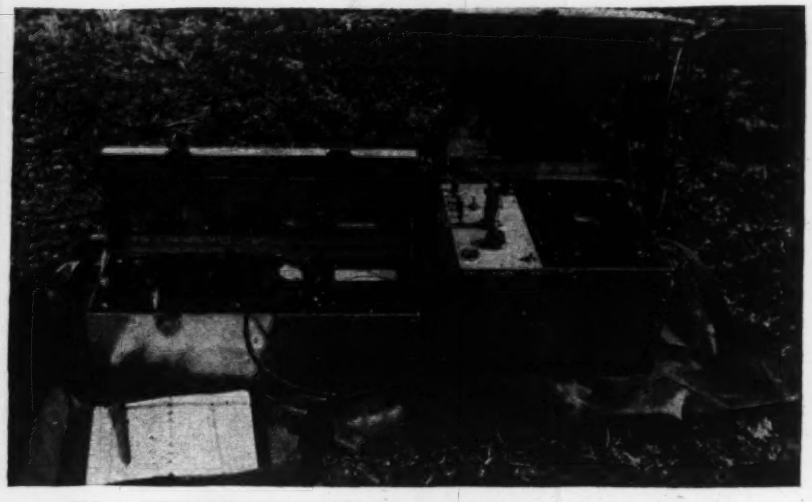


FIG. 2—INSTRUMENTS REMOVED from truck for survey in locations inaccessible to the truck.

not surprising when rocks or soils apparently quite similar may vary in this respect by several thousand per cent. Electrical conductivity (or inversely, resistance measurements taken on the surface area) has thus proved to be a great aid in revealing the secret of what lies below.

Both high- and low-frequency alternating current, and direct-current circuits are used in geophysical survey instrument design. The alternating-current devices operate on the induction principle: the higher the frequency the greater the exciting power, an advantage offset at high frequencies by diminished penetration. These instruments are best suited to locating mineral bodies classed as conductors. The area under investigation is energized by a primary electromagnetic field exciting the conductors present and causing them to re-radiate and distort the total field. A study of the total resulting field enables the operator to locate the disturbing bodies.

The direct-current instruments are designed so that the current is alternated through the earth because direct current will polarize the earth electrodes. This difficulty may be overcome by special non-polarizing electrodes, by alternating and rectifying the current or by instantaneous currents. In any case the design of the direct-current instrument is such that it measures only ohmic resistance—that is, the resistance to the flow of direct current.

Earth-resistivity methods

The particular circuit used by the author for his sand and gravel surveys is known as the Gish-Rooney Four-Electrode Earth-Resistivity Apparatus. This instrument was patented in 1927 by Dr. O. H. Gish, of Carnegie Institute, Washington, D. C., and has been used with credit all over the world as a valuable aid in the study of shallow subsurface problems. Much has been written about the use of this instrument and others designed for the same purpose. The author refers those who would be interested in a bibliography on the subject to Dr. C. A. Heiland's article, "Geophysics in the Nonmetallic Field," American Institute of Mining and Metallurgical Engineers, Vol. 110, pp. 572 to 576.

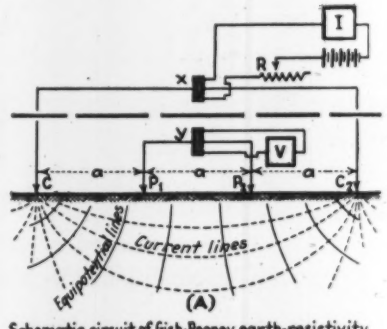
No attempt will be made to give a detailed description of the instrument; however, a general explantion of the principle of its operation will be in order. Fig. 3A is a schematic diagram of the circuit, which is composed of two independent parts, the current circuit *I* above the dash line and connected to the electrodes *C-1* and *C-2*, and the potential circuit *V* below the dash line and connected to electrodes *P-1* and *P-2*. The battery *B* provides a source of current measured by the milliammeter *I*. After leaving *I*, the current is alternated at *X* before being introduced into the earth at *C-1* and *C-2*. The flow of current through the media is represented by the dotted lines. Since a difference of potential must exist between *C-1* and *C-2*, it is obvious that a difference of potential will also exist across *P-1* and *P-2*. The potentiometer *V* measures this potential after it is rectified back to direct current at *Y*.

The values of *V*, *I* and *a*, the electrode separation, provide the necessary data to measure the resistance of the media. The resistance in ohm-feet being equal to $2\pi a \frac{V}{I}$ if *a* is measured in feet, and is a specific value, providing the medium of *M* is homogeneous, isotropic and of great extent compared to *a*.

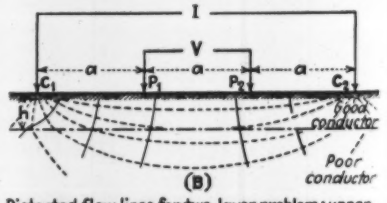
For the two-layer problem (Fig. 3, B and C) the resistance value measured is an apparent one depending on the specific resistances of the two media and their position with respect to the electrodes. Fig. 3B illustrates a simple case, as for instance a sand or gravel body covered with clay. Notice how the flow lines (dotted) are crowded along the surface with an increase in current density and an increase in the spread of the equipotential lines between *p1* and *p2*. Since the density of the equipotential lines determines *V*, it should be apparent that the measured resistance for Fig. 3B will be less than for Fig. 3C when the order of the layers is reversed with a corresponding change in flow pattern. It should also seem reasonable that the quantities involved in these earth-resistivity illustrations are so related that it is possible to determine the unknown depth *h*, providing the other variables are measured. It can be shown by an elaborate mathematical analysis how these variables are tied together for one or any number of layers; however, it is only necessary to state two non-mathematical principles that suffice to show how simple the interpretation of earth-resistivity data can be for elementary problems. Here they are:

Statement of principles

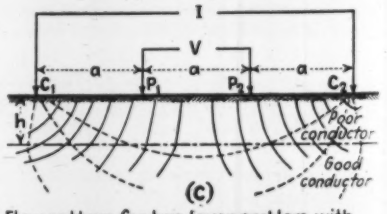
If the electrodes are progressively moved forward along a traverse with a fixed interval *a*, small enough so that the effective section can be considered made up of two layers of different resistance —i.e., clay over gravel—then the functional relationship between the depth of the lower layer and the apparent resist-



Schematic circuit of Gish-Rooney earth-resistivity apparatus and flow lines for homogeneous media M.



Distorted flow lines for two-layer problem; upper layer good conductor; lower layer poor conductor



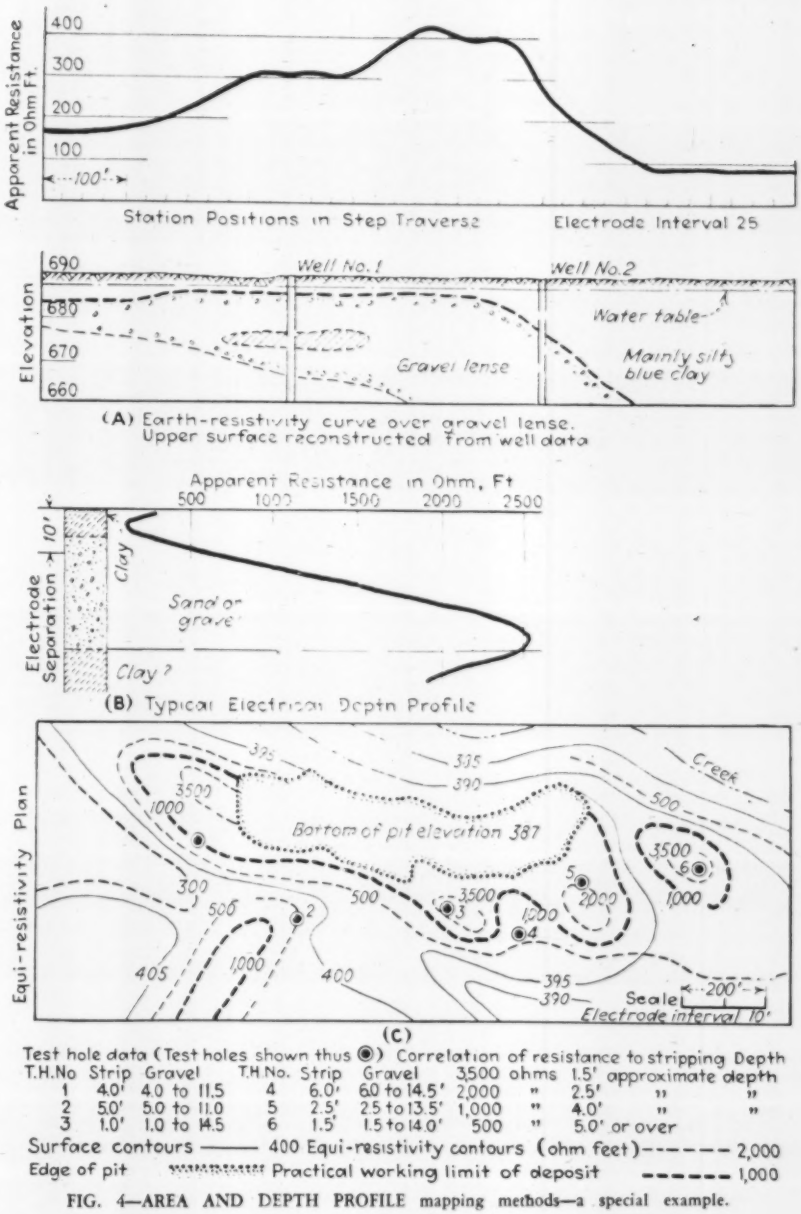
Flow pattern for two layer problem with layers reversed from (B)

FIG. 3—ACTION of earth-resistivity instrument indicated diagrammatically for different subsurface conditions.

ance at the surface can be expressed as a curve. This curve may be calculated mathematically or may be constructed empirically from test-hole data. (See resistance depth of stripping correlation on Fig. 4A and Fig. 4C.) Once the correlation between the depth of the discontinuity and the apparent resistance is established, it is possible quickly to outline or map with facility and surprising accuracy materials of different specific resistances. This technique is known as the step-traverse method.

Sometimes a picture of the vertical variation of resistance is desired rather than a plan survey. To attain this end, the electrode spacings are progressively increased over a fixed point. The apparent resistance is plotted against the electrode separation. A change in the slope of this curve means a change in the resistance of the earth section, which seems to occur at a depth equal to *a*. (See Fig. 4B.) This simple interpretation of depth profiles, as they are called, must be used with caution; however, the remarkable accuracy of the method for many two-layer problems justifies its use. For multiple earth layer set-ups this empirical method must be used with caution, as serious errors will occur when an attempt is made to correlate a series of slope changes with stragraphic horizons. For more than two layers the mathematical method is indicated. The mathematical treatment is quite complicated and can only be applied by an expert in earth-resistivity geophysics.

The depth profile method has been used for several years as a quick and fairly reliable one for sounding rock for dam-site and tunnel investigations. It is also being used by engineering firms for predicting the classification of earth materials previous to excavation and also for locating the water table. The step-traverse method will outline earth-resistivity high or for areas which correspond to those underlain by materials of a certain classification. It is in this method that the author is particularly interested, and it will be elaborated in some detail.



Test hole data (Test holes shown thus ◉)						Correlation of resistance to stripping Depth				
T.H.No	Strip	Gravel	T.H.No.	Strip	Gravel	3,500 ohms	1.5'	approximate depth		
1	4.0'	4.0 to 11.5	4	6.0'	6.0 to 14.5'	2,000	"	2.5'	"	"
2	5.0'	5.0 to 11.0	5	2.5'	2.5 to 13.5'	1,000	"	4.0'	"	"
3	1.0'	1.0 to 14.5	6	1.5'	1.5 to 14.0'	500	"	5.0' or over		

Surface contours —— 400 Equi-resistivity contours (ohm feet)- - - - - - 2,000
Edge of pit ▪▪▪▪▪▪▪▪▪▪ Practical working limit of deposit - - - - - - 1,000

FIG. 4—AREA AND DEPTH PROFILE mapping methods—a special example.

Prospecting for sand and gravel

The increased demand for highway surfacing and subgrade-treatment material along with decreased budgets has brought attention to the possibility of exploiting roadside deposits of sand and gravel. Highway research laboratories are finding ways to utilize to the best advantage cheaper materials of this nature. The important cost consideration is dead haul; and to keep it at a minimum consistent with quality, considerable prospecting for new deposits, and inventories of known ones are necessary.

The conventional way to hunt gravel is to run down what leads can be detected on the surface with an auger and shovel. This means a lot of random digging in areas deficient in these materials. When a test hole produces, it is still a big problem to outline the deposit in order to obtain an idea of the probable yardage. In fact in some areas prospecting may be so discouraging that long hauls will be considered inevitable. A competent geologist in the glaciated terraine can do much to eliminate unfavorable areas and can point out likely spots to test. However, where there is considerable cover, the problem seems to be largely a matter of luck.

Sand and gravel are electrically very resistant compared to weathered top soils, clay, loess and silt. The electrical-resistance determinant of earth materials appears to be more a matter of physical conditions than chemical composition—a question of colloidal or granular state in which water plays a dominant rôle. When the interspaces between the minute particles are so small that moisture is retained in spite of apparent dryness, the substance has electrical continuity which disappears as the size of the grains increases.

Readings in western Minnesota

The writer has found that the extreme drought conditions current in western Minnesota, where he has taken hundreds of readings, do not appreciably affect the resistance anomaly between clay and gravel. With very few exceptions, it so far appears that materials other than rock, which give high resistance readings in the field, possess low capillarity, making them suitable for fill material resistant to frost-boil action. Even when the subsoil is saturated with water, the resistance anomaly is sufficient to differentiate sand or gravel from silt and clay (Fig. 4A).

The resistance reading cannot of course distinguish between sand and gravel although boulders near the surface can generally be predicted because of the high readings and the low sensitivity of the instrument whenever they are over such deposits.

The technique for prospecting for a deposit and exploring it afterwards is carried out in the following manner. First, all the known pits are inspected to determine the geological occurrence of the deposits in the vicinity of a proposed project. Then further geological scouting is done to spot likely locations for geophysical tests. These are then tested by the step-traverse method, which consists of consecutive readings along a random line selected best to cover the prospect. It may be necessary to run several before the area is condemned or considered worthy of further exploration.

Considering that the instrument has a "hole equivalent" speed of 500 to 1,000 lin.-ft. per hour (25 to 50 readings), the saving in negative test holes at this point is considerable. If the electrically "high" area is sufficiently large to warrant test holes, then the prospect is gridded with parallel lines and an equi-resistivity plan is made (Fig. 4C).

What is measured

The most common factor measured by the survey is the thickness of the stripping, providing the gravel is deep and a suitable electrode interval is chosen so as to regard the problem as a two-layer one (Fig. 4A). Sometimes, however, when the stripping is uniform, it is more of an advantage to coutour the base of the deposit as illustrated by Fig. 5A. Or again, a composite picture of the top and the base is desired which can be arrived at by two electrode intervals (Fig. 5B). Notice how curve *a* for small intervals is not appreciably affected by the base of the deposit, while *b* clearly contours the base. The quality of the material also is a variable, calcareous and shaley gravel are less resistant than those derived from granitoid rocks, and gravels with weathered coatings on the pebbles or containing clay inclusions are also less resistant —note the high values Fig. 5C for indurated gravel.

At this point the reader might naturally infer that the numerous variables would make the instrument rather uncertain; the answer is that they do not because they are all accumulative—that is, high values mean either thin stripping, a very thick deposit if the stripping is heavy, or a high-grade deposit—all factors in favor of further exploration. Low readings on the other hand have never yet produced usable material for one reason or another just inferred from the above consideration.

After the earth-resistivity survey plan has been made, test holes are dug to sample the material for further classification and for laboratory analysis. The holes also supply the control for the electrical survey, often making possible some simple correlation between the resistance values and a useful material horizon (Fig. 4C). They are spotted at critical points such as on the electrical contours and also arranged in a way that will supply the necessary classification data with a minimum of digging. Finally a stadia survey is used to tie the whole project together.

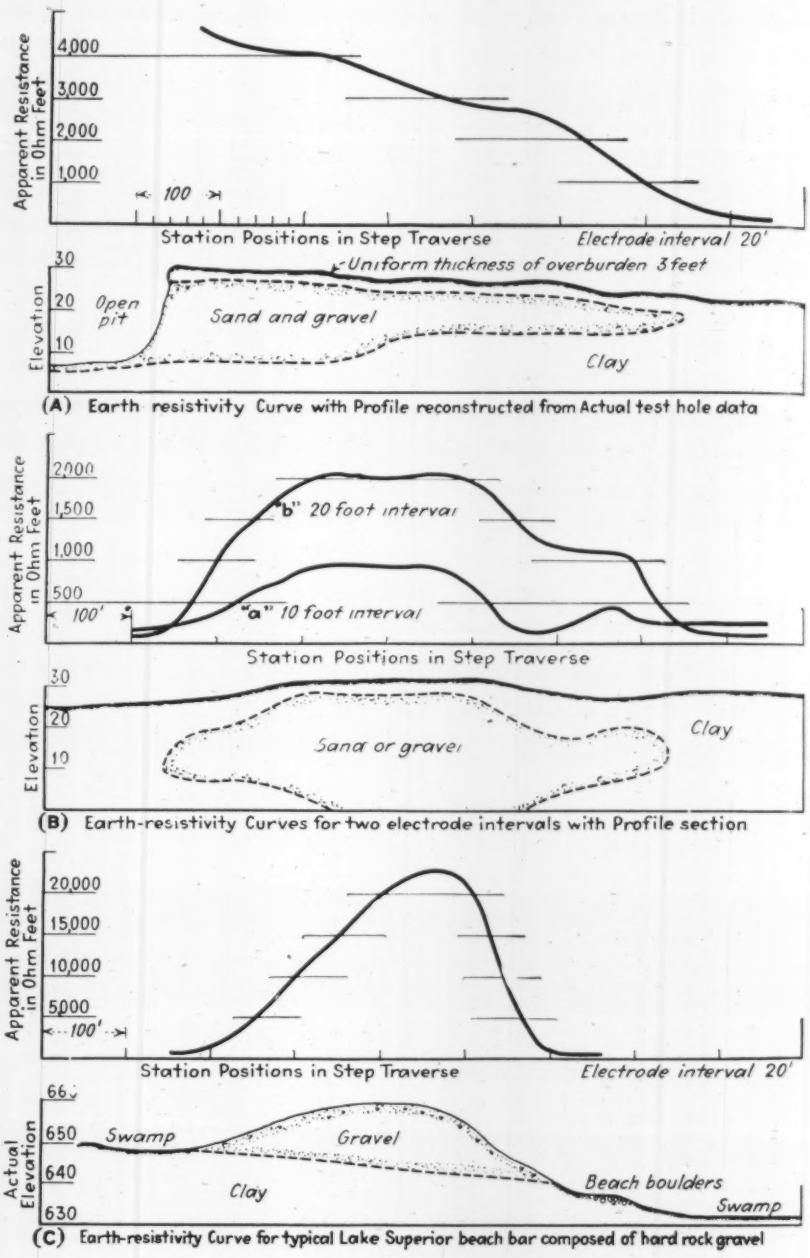


FIG. 5—EXAMPLES of earth-resistivity curves superimposed on aggregate deposits as actually disclosed by test holes.

Conclusion

Earth-resistivity prospecting and exploration have been used by the state of Minnesota department of highways for more than a year in which more than 100 prospects have been tested in 30 counties in all sections of the state. Not more than 2 per cent of the test holes dug have failed to verify the predictions of the electrical data, and those were in a submarginal class of material.

The geophysical survey as carried out in Minnesota enables the operator to predict subsurface conditions with a degree of certainty quite perplexing to the uninitiated, and quite satisfying to those responsible for finding the necessary materials for highway construction and maintenance.

Prestressed Concrete Pipe Tested at Purdue

By Ray B. Crepps
Assistant Professor of Testing Materials, Purdue University, Lafayette, Ind.

COMPREHENSIVE STUDIES have been made at Purdue University on 30-, 42- and 60-in. diameter prestressed concrete pipes, with exact measurements for stresses in the steel rods and concrete when the pipes were being prestressed and with internal fluid pressures in the prestressed pipes. Somewhat similar studies of a concrete beam with prestressed steel and concrete have also been completed (*ENR*, Sept. 13, 1934, p. 345).

These pipes differ from the conventional reinforced pipe: first, in that the bond normally formed between the steel and concrete was prevented by a suitable coating material on the rods at the time of fabrication; and second, in that both hoop and longitudinal rods were provided with threaded ends and nuts in castings in the wall of the pipe so that they could be prestressed in tension, in order to induce compression into the concrete. Fluid pressure in the pipe finds resistance from these initial stresses in the steel and concrete.

The measurements from tests, which are typical for all three sizes of pipe, are shown in the accompanying three diagrams for the 60-in. pipe only. This pipe had a wall thickness of 4½ in. and was reinforced with ⅛-in.-diameter hoop rods, 4½ in. c. to c., and by fourteen ⅛-in.-diameter longitudinal rods. The concrete had a modulus of 5,373,000.

Prestressing the hoop steel to 29,000 lb. per sq.in. (Fig. 2) induces in the concrete a compression of 455 lb. per sq.in. on the outside surface and 700 lb. per sq.in. on the inside surface. Thus the outside surface receives approximately 80 per cent of the average prestress in the concrete, and the inside surface receives about 120 per cent.

When a fluid pressure of 100 lb. per sq.in. is introduced into the 60-in. prestressed pipe, there results (Fig. 3) an increase of approximately 4,850 lb. per sq.in. stress in the hoop steel and, at the same time, a release of 480 lb. per sq.in. in stress in the concrete on the outside surface of the pipe.

Combining the stresses in steel and concrete from prestressing and fluid pressure (Fig. 4), there results a total steel stress of 33,850 lb. per sq.in. and a net outside stress of 25 lb. per sq.in. in tension in the concrete.

The system of parallel diagonal lines appearing in Fig. 4 indicates the resultant effect of the several combinations of prestressing and fluid pressures. For this particular pipe, in order that tension shall not exist in the concrete, an internal fluid pressure of 120 lb. per sq.in. would require a 36,500 lb. per sq. in. prestress in the hoop steel, whereas a pressure of 80 lb. per sq.in. would require a prestress of only 24,000 lb. per sq.in. It is understood that a prestress in the longitudinal steel equal to that in the hoops is maintained in the data of Fig. 4.

On several occasions this 60-in. prestressed pipe has been subjected to 160 lb. per sq.in. hydrostatic pressure, the result of which was the opening up of a few cracks on the outside surface; upon release of this pressure, these cracks have closed up, making their detection very difficult. No trace of moisture has been seen at any point in the pipe at any time.

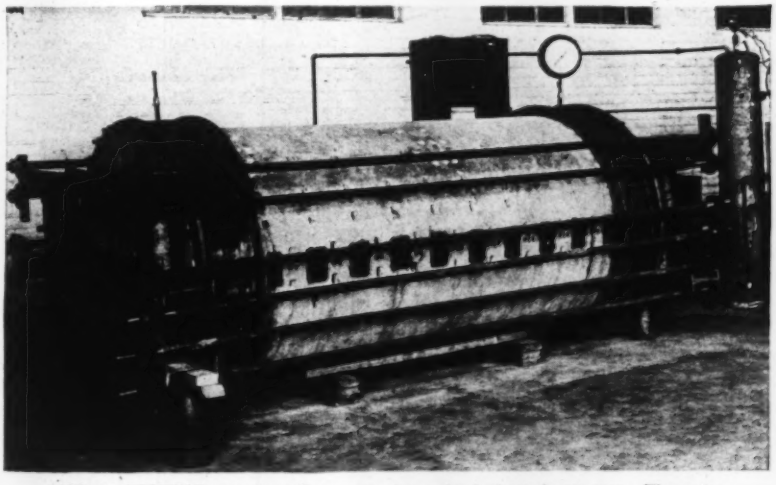


FIG. 1—TESTING a prestressed concrete pipe under hydrostatic pressure. The series of black squares are insert boxes, to accommodate the nuts on the threaded ends of the hoop rods.

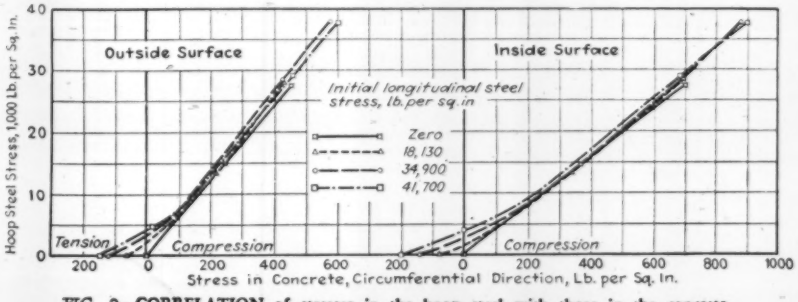


FIG. 2—CORRELATION of stresses in the hoop steel with those in the concrete produced by prestressing the steel in a 60-in.-diameter pipe.

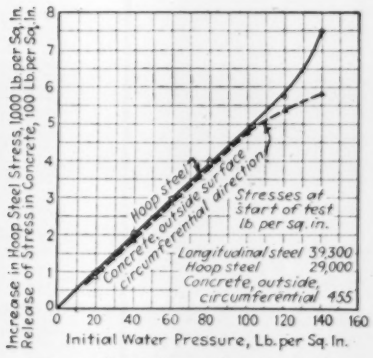

Increase in Hoop Steel Stress, 1000 Lb per Sq. In.
Release of Stress in Concrete, 100 Lb per Sq. In.
Hoop steel
Concrete, outside surface circumferential direction
Stresses at start of test lb. per sq. in.
Longitudinal steel 39,300
Hoop steel 29,000
Concrete, outside, circumferential 455
Initial Water Pressure, Lb. per Sq. In.

FIG. 3—CHANGES in stresses in hoop steel (increased tension) and in concrete (decreased compression) due to internal fluid pressure in a 60-in.-diameter pipe.

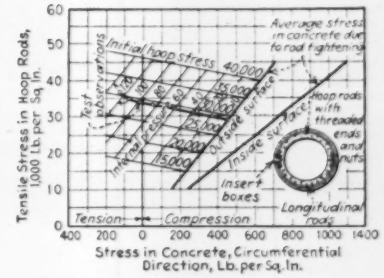


FIG. 4—SUMMATION EFFECT of prestressing and fluid pressure in a 60-in.-diameter pipe. For a given internal fluid pressure there is a minimum initial stress required in the hoop bars below which tension will occur in the concrete.

Technology of Emulsions for Surfacing Floors

By L. Kirschbraun
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THE EARLIER TECHNIQUE of producing floorings with asphalt emulsion consisted in making simple mixtures with aggregate. This practice had a serious practical drawback—the setting of such a composition was dependent largely upon the drying conditions prevailing on the job. In view of the fact that the setting action was one merely of evaporation, the time required for the floor to be put into service varied greatly and was relatively uncontrollable. This was a particular disadvantage in maintenance or in resurfacing work when adverse drying conditions were encountered, and when floors could not be readily withdrawn from service for a protracted period.

Research develops remedy

Experimentation was undertaken to discover means of overcoming these practical obstacles. As a result we found that certain dehydrating agents could be employed to produce a definite set, and by chemical combination remove a substantial portion of the water. Ordinary portland cement was found to be an excellent agent for this purpose. Especially prepared gypsum has likewise been successfully employed.

These agents, when mixed in proper proportion with the emulsified asphalt and aggregate, not only assisted in removing the water but also effected initial hardness by the hydraulic set of the cement itself, independent of the binding action of the bitumen. The mechanism of setting was: (1) the formation of a hydraulic cementitious structure binding together the remainder of the constituents; and (2) after the further dehydration of the composition and particularly after it had been subjected to kneading, the relatively weak structure of the hydraulic binder broke and was simultaneously replaced by the bituminous binder.

It was found, however, that in order to apply it satisfactorily, precautions must be taken to cure the mixture so as to prevent cracking. The amount of water present far exceeded the optimum cement-water ratio. On account of the relatively large water content, the change in volume and shrinkage was great; and to prevent cracking, it was necessary that the evaporation of the water be delayed until the hydraulic binder could obtain sufficient strength to resist contraction strains. This involved a period of curing before permitting the floor to dry out completely. Even under those conditions, if the floor were not subjected to rolling traffic, the continued hydration of the portland cement would eventually produce shrinkage cracks. On the other hand, with sufficient traffic to release the strains set up during the final stages of dehydration, this cracking could be avoided.

Reduction of water content

Attempts to reduce the amount of water present in the mixtures encountered the difficulty of producing one that was dry and unworkable by hand; or if coarse aggregate were used, the additional difficulty presented itself of densifying and closing up the mix to produce a smooth surface.

It was determined to study this problem with a view to ascertaining the limiting factors in reducing the water content. A series of mixture compositions was made up starting with a constant of 1 volume of cement to 2 volumes of emulsion, to which were added progressively increasing amounts of fine and coarse aggregate. The particular purpose was to ascertain to what extent water could be reduced by the addition of aggregate and still produce a mixture that would be coherent and traffic-resistant after drying. These mixtures were made starting with those of known experience—namely, 1 cement, 2 emulsion, 3 sand; and 1 cement, 2 emulsion, 2 sand, 3 gravel, and using the same emulsion, sand and coarse aggregate throughout.

The ingredients to be mixed were prepared in a mechanically operated paste mixer for exactly 3 min.; the sand, cement and sufficient water to give a heavy paste were mixed, and then the emulsion was added. All of the mixtures were applied on the same day to

FIG. 1—PENETROMETER for testing set of aggregate and emulsion mixtures for floor covering.

TESTS OF EXPERIMENTAL MASTIC FLOORS TO DETERMINE LEAST LIMIT OF HYDRATION

Mix*	Cement Grams	Emulsion Gr.	Weight Sand Gr.	Gravel Gr.,	Water CC.	Per Cent by Weight on Wet-Mix: Cement Per Cent	Emulsion	Sand	Gravel Per Cent	Added Water Per Cent	Water in Emulsion as Per Cent Wet Batch	Per Cent Total Water on Wet Batch
1-2-3 (3-6-9)	1800	2880	5626	....	1650	15.1	24.0	47.2	....	13.8	9.0	22.8
1-2-4 (3-6-12)	1800	2880	7500	....	1760	13.0	20.4	53.9	....	12.7	7.7	20.4
1-2-5 (2-4-10)	1200	1920	6250	....	1200	11.4	18.1	59.1	....	11.4	6.7	18.1
1-2-6 (2-4-12)	1200	1920	7500	....	1300	10.1	16.1	63.0	....	10.9	6.0	16.9
1-2-2-3 (2-4-4-6)	1200	1920	2500	4200	1200	10.9	17.4	22.7	38.1	10.9	6.5	17.4
1-2-3-4 (2-4-6-8)	1200	1920	3750	5600	1200	8.8	14.1	27.6	40.7	8.8	5.2	14.0
1-2-3-5 (2-4-6-10)	1200	1920	3750	7000	1300	7.9	12.7	24.4	46.3	8.6	4.7	13.3
1-2-3-6 (2-4-6-12)	1200	1920	3750	8400	1400	7.2	11.5	22.6	50.3	8.4	4.3	12.7
1-2-2-6 (2-4-4-12)	1200	1920	2500	8400	600	8.2	13.0	17.2	57.6	4.1	4.9	9.0

*Constituents in the order named: first, cement; second, emulsion; third, sand; fourth, gravel.

FIG. 2—RAKING AND TAMPING emulsion mixture for factory floor.

adjacent sections of floor, so as to avoid any differences in temperature and humidity. The application areas were 1x3 ft. x ½ in. thick.

The consistency of the wet mixtures was controlled by the A.S.T.M. standard slump tester. A composition having a good troweling consistency was found to have a slump test of about 3 in. All flooring mixtures used in these experiments were adjusted to this consistency by the addition of the necessary amount of water. All proportions are by volume except where otherwise specified.

The mixtures were applied ½ in. thick to a concrete floor that had previously been primed with a coat of emulsion. Screed boards were used to obtain the correct thickness. The sections were then finish-troweled with a steel trowel. Each mixture was applied in duplicate, one section being allowed to set without retardation of drying and one section being cured by covering with a wet felt for 24 hours.

The composition of these mixtures is given in the accompanying table. The mixtures were made by volume, but the corresponding weights are likewise recorded, including the amount of water added. All calculations are on the basis of a final weight composition.

Of the sand mixtures, the dried compositions were cohesive and appeared to contain sufficient asphalt until the proportion of sand reached the composition 1 cement, 2 emulsion, 6 sand. Mixture 1 cement, 2 emulsion, 7 sand (not recorded here), was not coherent and crumbled on the application of pressure when dried. In the series containing gravel, the coherence of the dried mix was sufficient up to and including the ratio 1 cement, 2 emulsion, 3 sand, 6 gravel.

From the percentage of water contained in the foregoing mixes and from the determination of a volume of a given weight of wet mix, it is possible to calculate the amount of water present per unit area ½ in. thick, as follows:

Mix	Grams Water Per Sq. Ft.
1-2-3	425.1
1-2-4	415.0
1-2-5	378.1
1-2-6	362.1
1-2-2-3	388.4
1-2-3-4	307.8
1-2-3-5	290.3
1-2-3-6	264.5
1-2-2-6 (dry mix)	205.0

It is apparent that one of the most important factors in shrinkage and setting of the mixtures is the amount of water present and to be removed per unit area flooring. The tabulation shows that by the introduction of more aggregate, and particularly coarse aggregate, the amount of water present in the most extended mixture could be reduced to almost half of that present in the standard mix of 1 cement, 2 emulsion, 3 sand. This, of course, was confined to mixtures in which the amount of aggregate was limited to that which would still produce a coherent floor.

It should be understood that all of the foregoing mixtures were prepared so they could be laid and floated by hand. This necessarily still involved the use of excessive quantities of water for a proper cement-water ratio. Mixtures were prepared with still smaller quantities of fine aggregate, such as 1 cement, 2 emulsion, 2 sand, 6 gravel, but such mixtures could not be readily worked up by hand to finish with a smooth dense surface. This point should be borne in mind in connection with later discussion.

Setting time

It was desired to note further the effect of variation of composition, including water content, for the setting properties of these flooring mixtures. For determination of initial and final set, an instrument was used of the penetrometer type, using a round shaft having a bearing area of 1 sq.in. It consists of a piece of shafting properly supported and carrying weights. An ordinary penetrometer (minus the needle) is mounted above the rod so as to record the depth of penetration. A steel ring is cemented to the floor and filled with water for maintaining constant temperature when desired. The initial set was arbitrarily taken as the time required to give with this instrument an indentation between 10 and 15 tenths-millimeters under a 10-lb. load acting for 2 min. Final set was construed to be that time at which a similar indentation was produced under a 100-lb. load operating for 2 min. These figures roughly correspond to the time at which the floor would support the weight of a man without serious marring and, at final set, to that degree of hardness which would permit the use of the floor in service. Records of initial and final set were obtained on both retarded areas and those areas in which the drying was not retarded.

The results show generally that as the amount of aggregate of both types was increased, the initial set was accelerated. As was to be expected, the initial set was delayed somewhat on areas where the drying was retarded, as compared with the same areas allowed to dry normally. Likewise, with both types of mixtures (sand and sand and gravel) the period for final set was accelerated with increasing amounts of aggregate and correspondingly decreasing amounts of water. Decreasing the amount of water apparently shortened the period of final set much more markedly than the initial set.

These data showed conclusively the desirability of reducing the water content of these mixtures by any way possible that would still leave a composition containing sufficient bitumen to set to a cohesive and wear-resisting mix. Further reductions of water and further densification of aggregate could not be effected on account of the limitations of hand application, which necessitated a workable plastic mix and one containing sufficient water constituents to close up the troweled smooth surface.

Machine application

It was apparent that further effort to effect improvement in these mixtures through reduced water content would necessitate a type of application technique that could handle the relatively

drier mix and could close up one having smaller quantities of water constituent and the maximum quantity of large aggregate. This necessitated the development of some type of mechanical equipment for finishing.

Inasmuch as a somewhat similar problem prevailed in connection with the application of low-water-ratio cement floors, recourse was had to that type of equipment that had been evolved for machine finishing and floating cement floor mixtures. Through the cooperation of the Kelley Electric Machine Co., Buffalo, N. Y., various experiments were made to the end that the floor-float type of equipment that they had evolved for finishing cement floors might be adaped for use to asphalt emulsion floors.

The experiments show that by proper adjustment of the size of disks, weight per unit area, etc., that a machine of this type could be employed very satisfactorily and that, given such a machine, much drier emulsion mixes could be used and finished.

Furthermore, it was found to be unnecessary to overfill the coarse aggregate with the mortar constituent, as workability could be effected with the theoretical amount of mortar required to fill the voids in the coarse aggregate, such as in a 1-2-2-6 mix.

FIG. 3—EMULSION FLOORING screeded after tamping and smoothed by power finisher.

The type of machine finally adopted is illustrated by Fig. 3. This machine is considerably heavier in relation to the size of the floating disk than the power float used for cement-floor finishing. The method of preparing floors when using this machine is illustrated by Figs 2 and 3.

Difficult Caisson Problems Overcome in Sinking Deep Piers—II

Conclusion of article describing work on the foundations for the San Francisco-Oakland Bridge—Experiences with individual caissons with comments on design and lessons learned in sinking

By C. H. Purcell, Chas. E. Andrew and Glenn B. Woodruff
Chief Engineer, Bridge Engineer and Engineer of Design, San Francisco-Oakland Bay Bridge

FOUNDATION WORK on the San Francisco-Oakland Bridge was naturally divided into two sections by Yerba Buena Island. Four caisson piers of the domed type were sunk for the West Channel crossing. This caisson work, involving new methods and record depths, resulted in some difficult problems and unusual experiences, which are reviewed in this two-part article, together with a comparison of the false-bottom caissons used on the East Channel crossing and with comments on design. The general problems of caisson construction and sinking as well as the detailed handling of W-6 were discussed in Part I (Feb. 14, 1935, p. 239).

Sinking caisson W-3

Caisson W-3 was floated to the site between the working docks on Dec. 27, 1933, and anchored by Jan. 3, 1934. The caisson was landed on mud Jan. 21, and the cutting edge sank 9 ft. to El. —79.4; in this operation the air pressure was dropped from 25.4 to 17.1 lb. By Jan. 29, concrete had been carried to 104 ft. above the cutting edge, and the cofferdam was 10 ft. higher. The weight of the concrete placed after landing caused mud to rise 30 ft. in the cylinders and water 62 ft. above the cutting edge, which penetrated 24 ft. into the mud to El. —94.

As the caisson sank, the mud tended to plug as it was forced up through the adaptor sections at the base of the cylinders and acted as a false bottom; a considerable quantity of mud was displaced under the cutting edge. On Jan. 29 the air pressure was dropped from 15.8 to 12.3 lb., with no resulting settlement of the caisson. When the pressure was lowered to 6.5 lb., the plugs gave way, and the cutting edge dropped from El. —94 to —102 at the north and —99 at the south. The air was further reduced at the south end, and the caisson was leveled, with the cutting edge at El. —103.5.

While raising cylinders, on Feb. 5 it was decided to excavate to break out the plugs before replacing the domes. While excavating in two of the north cylinders, the material blew in, raising from 31 to 55 ft. above the cutting edge, and suddenly dropping the north end of the caisson 4 ft.

The drop of the caisson on Jan. 29 was fortunate because the mud plugs first gave way on one end rather than along one side. Had the latter happened, a serious tipping of the caisson might have resulted. If the weight of the caisson had been less, as a result of maintaining the top of the concrete 20 ft. below water surface, the sinking of the caisson would have been controlled longer by gradual reduction of air pressure. Under such circumstances it would have been possible to have destroyed successively the mud plugs before the false-bottom condition was reached. With conditions as they were, when the caisson did not respond to the

first drop in air pressure, it would have been more prudent to have restored the original pressure and released it entirely in one end cylinder at a time. In case the plug did not break, the dome should have been removed, the plug removed by dredging and the dome replaced.

Sinking caisson W-4

Caisson W-4—the anchorage pier between the two suspension spans—was towed to the site Nov. 8, and landed in mud on Dec. 22. On landing, the cutting edge entered 9 ft. into the mud to El. —78.6. After landing the caisson, air pressure was slowly reduced, and water was pumped into the cylinders during the process, to balance pressures at cutting-edge level. When the cutting edge had penetrated 20 ft. into the bottom, mud had risen about 25 ft. into the cylinders and formed a plug in the adaptor sections; the caisson was practically resting on a false bottom.

On Jan. 2, the caisson took a list of 2.1 ft. to the south. For the next three weeks the caisson "rocked" back and forth during the several operations, the maximum list being 4.0 ft. on Jan. 5. On account of the large dimensions of the caisson (197x92 ft.), these lists gave little concern. On the 19th, excavation started on the second row of cylinders from the north side, and the caisson leveled on the 23d, after which dredging was balanced in the three center rows.

On Jan. 27, with the cutting edge at El. —98.5, about 30 ft. in mud, it was noticed that material was being displaced from under the cutting edge, as evidenced by the heaving of the working platforms. On the 29th, dredging was resumed. At 4 p.m. on Jan. 31, the caisson was on an even keel with average heights of mud above cutting edges of 23, 13, 10, 15 and 23 ft. in the five rows of cylinders from north to south. The caisson started a slow movement, the north end being 3.0 ft. low at midnight and 5.2 ft. low at 7 a.m. (Feb. 1), the north side having settled 8.5 ft. and the south 2.6 ft. during the movement.

After the tipping, the north side of the caisson was nearly awash at high tide, and the cofferdam provided in the original design extended only 2.5 ft. above the concrete. To prevent further settlement, the contractor raised five cylinders in each outside row to El. 149, welded the domes in position and put on a 15-lb. air pressure. Because of the mud plugs it is probable that this air pressure had no effect.

To gain freeboard, the next operation was to raise concrete to El. 126.0 above the cutting edge. Domes were put on all north side cylinders, the pressure was raised to 29 lb., and all air was released on the south side. This had no effect on the list. The south two rows of cylinders were dredged to an average of 8 ft. above the cutting edge, while on the north side the average was 24 ft. above the cutting edge. To add weight so as to produce a righting moment, concrete was carried up on the south side to El. 137.5.

On the 11th the list started to reverse, the caisson was level at noon of the 13th, and at 9 p.m. on the 13th there was a list of 8.40 ft. to the south. During the operation the mud rose in the south cylinders of the caisson. All these movements were very slow, and at no time was there any sudden displacement of material. There was a considerable movement of material out from under the cutting edge, both working docks being pushed up about 5 ft.

These indications were evidence that the caisson was too heavy and that pressures at the cutting-edge level were beyond the sustaining capacity of the soil. It was evident that the weight should be kept as low as possible until the cutting edge encountered a material with more sustaining power. The first operation was to pump the water down about 10 ft. in the cylinders, the next to complete the concrete cofferdam to El. 137.5. A small amount of dredging was done in the north and center cylinders, and the caisson came back to level.

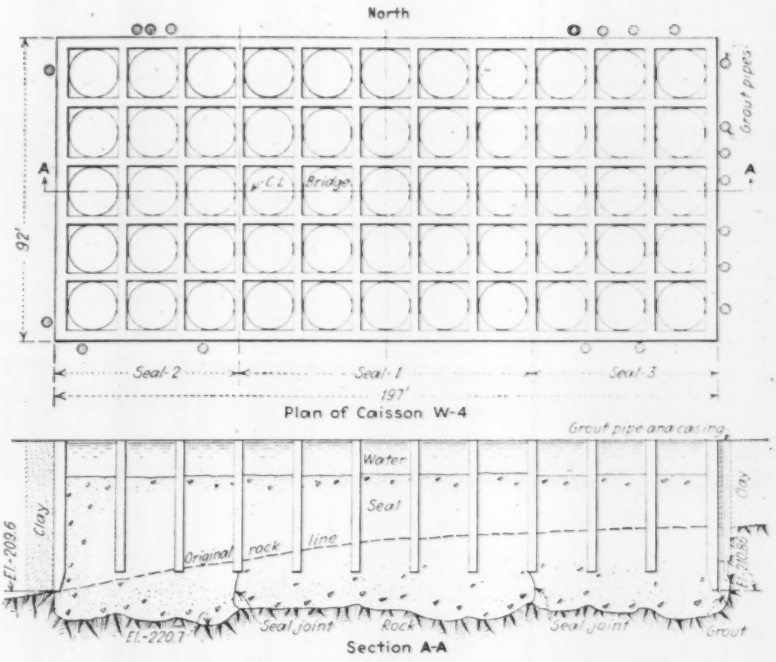
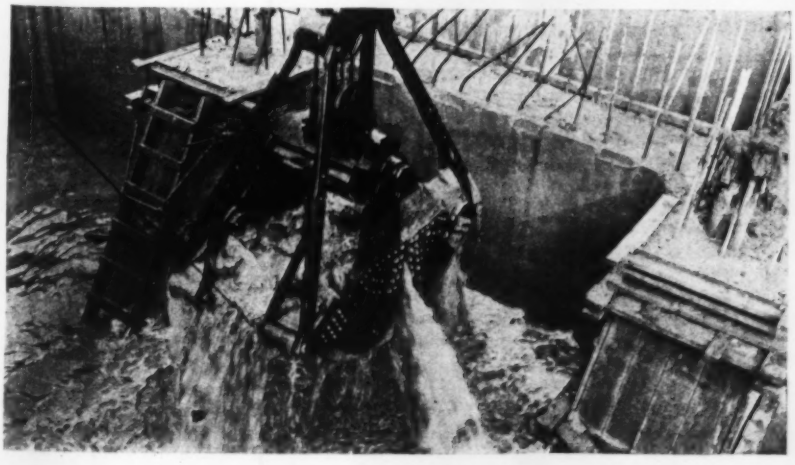


FIG. 2—CAISSON W-4 landed on irregular rock surface, and the cleaning and sealing operation was aided by grouting along the sides.

FIG. 1—DREDGING in an outside row of wells in caisson E-5 with a 4-cu.yd. bucket. The outside walls of these wells do not extend to the water line, and the load in them will be transferred to the pier shaft by buttresses. After sealing, the outside wells are capped with reinforced-concrete slabs.



Sinking caisson W-5

In advance, caisson W-5 seemed to present the most difficulties of all West

Bay piers. It was 17.5 ft. narrower than the others and, therefore, had less inherent stability. The mud beneath was quite soft all the way to rock, which sloped from El. —100 at the south end of the caisson to —110 at the north end.

In spite of these difficulties, sinking operations on this caisson were more successful than on any other West Bay pier, and no unanticipated incidents occurred. Additional wales and struts were placed so that concrete could be kept low after landing. After the cutting edge was so embedded in the mud that there was no danger of horizontal

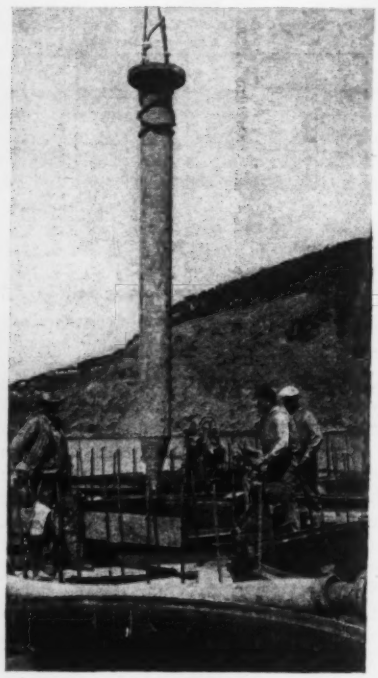


FIG. 3—FIVE-TON GAD used in breaking up concrete which flowed too far laterally during sealing operations. The gad was also used for breaking rock, to sink caisson W-4 into rock.

displacement, three anchor lines on each side of the caisson were moved up to a point near the caisson top, and a tension of 30 tons was put on each line. The release of air and the first dredging operations were so conducted as to maintain symmetry.

As the cutting edge approached rock, the south end was carried about 2 ft. lower than the north end. Cylinders at the north end were raised successively from El. 105 to 115. To avoid the effect of the mud plug, the excavation was carried to the cutting edge, domes were replaced, and air pressure was reapplied.

Cleaning bottoms and sealing

In spite of the unprecedented depths, every possible precaution was taken to clean the bottom under each caisson thoroughly and to extend the seal to the extreme limits of the cutting edges.

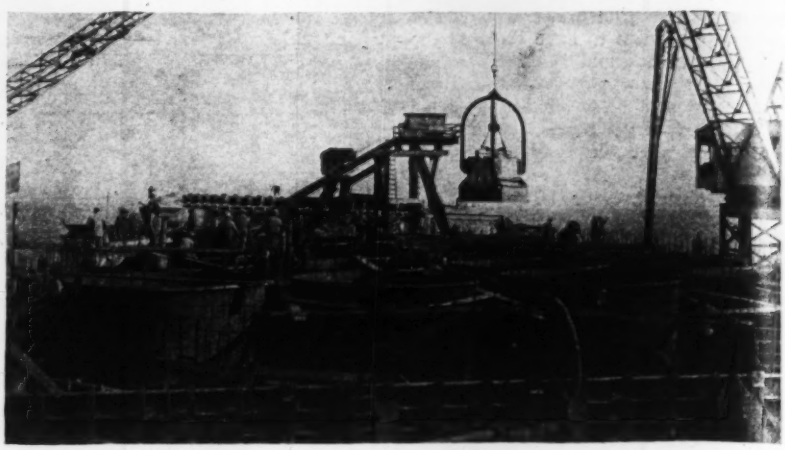


FIG. 4—SEAL CONCRETE was placed by a 4-cu.-yd. bottom-dump bucket. Note the pipe guides over the top of the bucket to prevent fouling under cross-walls.

Knowledge of the results obtained was insured by the services of an exceptionally able diver who directed the cleaning operations and inspected all surfaces against which concrete was to be placed.

In the West Bay all caissons were carried to rock, whose surface was extremely irregular. The sealing program was varied in each case to suit conditions. Preliminary borings had furnished approximate information as to the rock surface. As the cutting edge of each caisson approached rock, several jet borings were made in each cylinder, so the rock contours might be located accurately. It was necessary to seal each caisson in sections, since to clean the entire section at once would have resulted in tipping the caisson as the cutting edge came to bearing on the rock. Further, it would have been impossible to keep the seal concrete alive over the entire area.

The sequence of the sealing operations for the West Bay caissons is shown by Fig. 2. After the rock contours were determined, an approximate figure was established for the final cutting-edge elevation. The first seal area, consisting of a group of cylinders, was cleaned to rock, and material under the cross-walls was washed by jets into the dredging wells. In so far as possible the material adjacent to the seal area was left undisturbed so it might form a dam, to keep seal concrete from flowing into areas not cleaned. The remaining areas were excavated and jetted so as to lower the caisson as much as practicable and still keep it level.

Prior to placing any concrete, the seal area and the sides of the caissons were thoroughly washed with the jet and the resulting slime was removed with a pump or an ejector. The concrete was placed with 4-cu.yd. bottom-dump buckets.

After placing the first section, no work was done until the seal had set for seven days. After this period the remaining areas were cleaned, care being taken, where possible, to maintain symmetry about the first section of seal. In most cases, the mud dams had proved inadequate to prevent some flow of concrete into adjacent cylinders. This concrete was removed by dropping a "gad," a piece of heavy steel shafting, pointed at the striking end.

At W-4 the rock sloped from El. —180 at the east to —200 at the west end. During the tipping of the caisson, material at its sides became softened, so that dredging below the cutting edge was followed by an inflow of material from outside. To seal off outside material, it became advisable to sink the cutting edge into rock. Rock directly below the dredging wells was broken by the "gad," and shattered rock was jetted from under the cross-walls and cutting edge. By this means the cutting edge was lowered to El. —210.2. Cleaning the center 25 wells was finished June 17, and sealing followed immediately.

When cleaning of the end wells was started, examination by diver discovered that material had entered under the west cutting edge, and that the inflow continued as fast as the wells were cleaned. A similar condition developed at the east end. In both cases the incoming material consisted mainly of rock that had been crushed by the cutting edge. The inflow of material was stopped by grouting at cutting-edge level; the location of the grout pipes is shown in Fig. 2. In this operation 7,238 sacks of cement and 2,676 cu.ft. of sand were used.

At pier W-5 the rock slopes steeply to the north, and material overlying the rock is so soft that it afforded very little side support. In this case the north end of the caisson was supported by air until after the sealing of the south twelve cylinders.

In sealing the East Bay caissons, the cutting edge was lowered to the desired level by dredging, augmented by relieving jets. At piers E-4 and E-5 the center three wells were cleaned 15 ft. below the cutting edge and sealed. After

their seals had set, the twelve wells at each end were cleaned and sealed. A similar procedure was followed at caisson E-3 except that the first seal included the center twelve wells.

Comment on West Bay caisson design

The dome method of caisson control (*ENR*, April 5, 1934, p. 431) was used for the first time on West Bay piers. As might have been anticipated, experience on the work pointed the way for certain improvements and confirmed advance judgment on several features of the original design.

The box-girder design of the cutting-edge sections proved very satisfactory throughout. Fabrication was economical, and the construction provided sufficient rigidity during launching and flotation. The weight of the cutting-edge sections could have been reduced by using lighter plates, but this would have required more bracing so that the final cost would not have been reduced and the results would not have been as satisfactory. The absence of this bracing greatly facilitated the placing of concrete.

The system of steel struts and wales proved satisfactory in all respects; its erection proceeded very rapidly. The method provided for a high degree of rigidity. In the field, holes were burned through the beam webs, to permit the escape of entrapped air, so that better concrete encasement might be obtained.

In a redesign of these caissons the following modifications would be made:

1. The waling and strut system would be designed with such strength that the concrete might be kept so low that the load on the mud would not cause displacement of underlying material. This statement is admittedly and necessarily indefinite. Much depends on the lateral support given the caisson near its top and also on its dimensions. As an approximate rule, the writers would advise that until a solid subsoil is reached, the excess pressure at the cutting edge level should not exceed 1,000 lb. per sq.ft.

2. Provision would be made for venting the cylinders so as to reduce the weight of the caisson by blowing down the water to the top of the mud plugs. (These two modifications were incorporated in caisson W-5.)

3. An 8-in. pipe would be incorporated at each cross-wall intersection to assist in jetting material from under the cross-walls.

Comment on East Bay caisson design

The cutting edges of the East Bay caissons (*ENR*, Aug. 23, 1934, p. 233) were designed by the contractor, subject to the approval of the engineers. Experience proved them sufficiently heavy for their purpose, but the design should be considered as a minimum. The 4-in. timber for the outside cofferdam proved sufficient. In a redesign, however, 6-in. timber would be specified as the minimum, to increase the margin of safety.

The system of jet pipes built into the caissons was very satisfactory. Especially in E-3, it was possible to sink the caisson by use of jets when otherwise it might have been necessary to dredge below the cutting edge. The cutting-edge jets aided materially in cleaning the bottom prior to sealing. Their effectiveness at this stage would have been improved by closer spacing. Also, at this stage of the work, jets at the bottom of the cross-walls would have been of material assistance, but quite probably the installation cost would have been more than the saving.

Comparison of methods

The use of the domed cylinders has added a new method for the control of a concrete open-dredging caisson; the two heretofore most commonly used are the false-bottom method and the sand-island method. There is no doubt that each of the three methods has certain advantages; it becomes the responsibility of the designer to study the conditions and to choose the method best suited to each site.

The dome method has the advantage of a low center of gravity and is therefore very stable during the flotation period. Adjustment of the air pressure permits an even trim of the caisson even when the concrete is being placed in high lifts. The dome method also avoids the risks involved in false-bottom removal, has the advantage of permitting easy change to a pneumatic caisson, and the advantage that the caisson can be landed on the bottom in a very short space of time with small tendency for scour and no tendency to lift on succeeding high tides. This method is especially advantageous when landing on sloping rock with a small amount of overburden.

Disadvantages are that it is relatively expensive; the cost per cubic yard of caisson displacement is about 30 per cent greater than the false-bottom method. The caisson is comparatively heavy, which renders it unsuitable when loads must be kept at a minimum. On the other hand, this weight is of great assistance when heavy skin friction is anticipated or when the cutting edge must be forced through boulders or through rock. The successive operations involved in raising cylinders make the sinking slower than with other methods.

The false-bottom method, on the other hand, entails the risk involved in removing the bottoms, especially when the depths to mud are so great as to render a heavy false bottom necessary. In general, the writers would recommend placing enough supports so the timbers will not exceed 8 in. in thickness. With the dredging wells filled with water before removal of the false bottoms, this weight, combined with that of concrete to above the water line, is apt to overload the underlying soil and result in a tendency to upset the caisson. Where necessary, however, the caisson can be made very light weight in order to keep the soil pressures at a minimum.

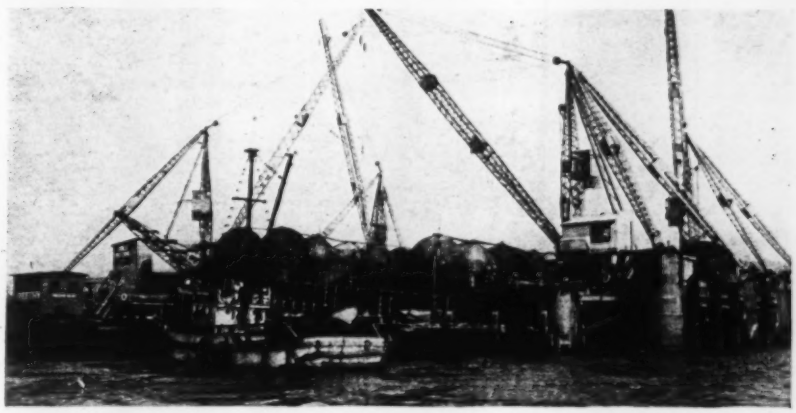


FIG. 5—CAISSON W-4 rocked from side to side during early stages of sinking into mud bottom, until material reached had sufficient supporting power.

Contractors and engineers

The contract for the piers in the West Channel crossing was executed by the Transbay Construction Co., of which C. F. Swigert is president, J. A. MacEachern general manager, Ben Cook superintendent, and C. P. Dunn chief engineer. I. O. Jahlstrom is resident engineer for the state. The contract for the piers in the East Channel crossing was executed by Bridge Builders Inc., of which H. J. Kaiser is president, E. H. Connor managing engineer, and C. B. Jansen superintendent. V. A. Endersby is resident engineer for the state.

The complete personnel of the California Toll Bridge Authority was listed in *Engineering News-Record*, March 22, 1934, p. 377. William Reed was the diver employed by the state as submarine inspector.

Fixed Derricks on Towers Build High Concrete Bridge

Six steel stiff-leg derricks cover entire site of new Calvert St. crossing of Rock Creek Valley in Washington, D. C.—Steel-truss centering for arches—All concrete truck-mixed on job—Precast soffit slabs between arch ribs

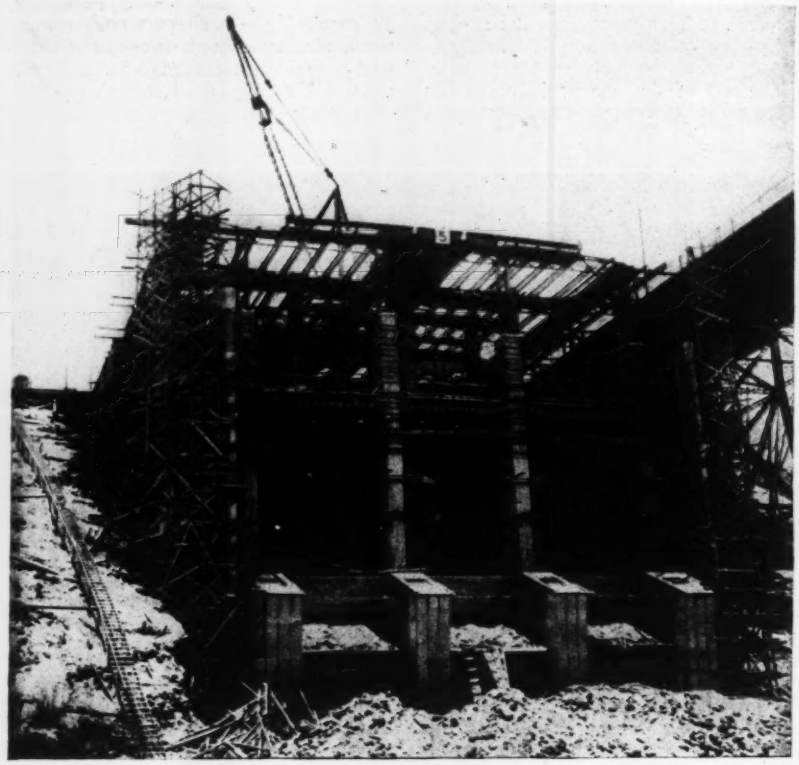


FIG. 1—ABUTMENTS of concrete-encased light steel framework, faced with limestone curtain walls. This view of the east abutment shows the scaffold staging used for setting stone, abandoned in favor of swinging scaffolds on the west abutment.

CONDITIONS at the site of the new concrete-arch Calvert St. bridge across deep Rock Creek Gorge in Washington, D. C., required careful consideration of the construction plant best suited to the job. With three arch spans and two long box abutments, totaling 751 ft. in length, the bridge spans the valley at a maximum height of 125 ft. from ground to deck and 138 ft. from the bottom of the deepest foundation to the roadway. Two of the high arch spans are over park driveways, and the third crosses Rock Creek. The sides of the gorge are steep and wooded, leaving the two park drives the only means of access to the job from below.

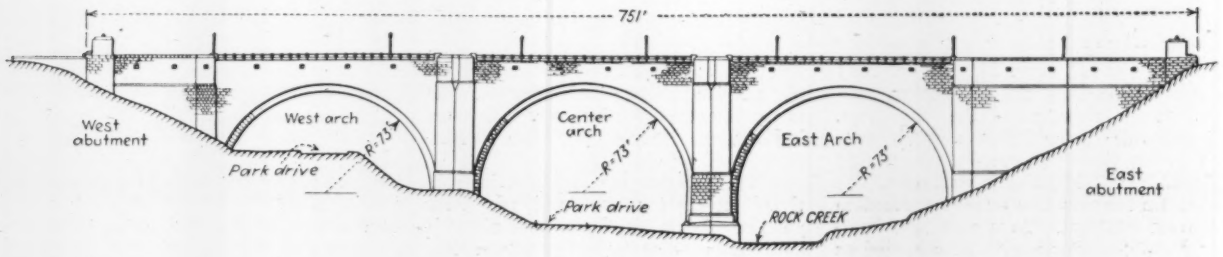
The topography at the site and the height of the structure precluded the use of the usual movable equipment for the main work, without the installation of a high temporary viaduct. The steel trestle existing at the site for 43 years had been moved to one side to provide a detour for traffic (*ENR*, June 21, 1934, p. 793). A cableway system was impossible because of limited space at the abutments, for the approaches to the detour are close to the ends of the new bridge. As a solution of the problem, the contractor selected a group of steel stiff-leg derricks with 100-ft. booms and placed them so as to cover the entire site. Two of the derricks, set on the abutments, served the abutment structure and half of the adjoining arches. On each of the two piers two stiff-leg derricks were installed on high steel towers to serve half a span of both adjoining arches (Fig. 4). Thus, with six derricks the whole length of the bridge was covered.

Design of bridge

The new bridge consists of three arches of 146-ft. clear span: two piers, 34 ft. and 39 2/3 ft. wide, and two structural box abutments. Each arch is made up of four concrete ribs 6 ft. wide carrying concrete-encased steel columns supporting the deck. Concrete-encased I-beams span between the arch ribs. The deck, a 60-ft. concrete roadway and two 12-ft. sidewalks (22 ft. on abutments), is carried on concrete-encased steel stringers which rest on concrete and steel transverse girders spanning between the tops of the columns. The columns and girders of the box abutment are lattice steelwork encased in rod-reinforced concrete (Fig. 6).

The entire exposed areas of the abutments and piers and the outside arches above the intrados are faced with limestone. Above the extrados of the outside arches and around the abutments the stonework is carried up as a curtain wall. The stone masonry has to be carefully set, as horizontal joints must be continuous and in perfect alignment for the entire length of the bridge. On the abutments the railings are stone, but over the arches combination ornamental wrought iron and stone hand-

FIG. 2—CONCRETE BRIDGE, faced with limestone, spanning Rock Creek Park at Calvert St., Washington, D. C., replaces high steel trestle built 44 years ago.



rails are called for. Brick gutters, granite curbs and an asphalt wearing surface are specified for the roadway. The roadway also carries a double-track streetcar line. A water main, gas main and electrical conduits are suspended from hangers beneath the roadway deck of the bridge.

A novel feature of design is a filling of precast slabs placed between the arch ribs at the intrados, to give the appearance of a solid barrel arch from below. These slabs are 19 ft. 4 in. long (between ribs) and 9 ft. wide. They are 3½ in. thick, heavily reinforced, with 8-in. flanges and two cross-ribs. Into each slab is cast lifting stirrups and anchor bolts. They are to be hung in place by anchor bolts, which fasten to straps over the I-beams spanning between ribs. There is required a ⅜-in. clearance between slabs, and between slabs and ribs, necessitating careful building of the slab forms. The slabs are curved to follow the radius of the arch soffit.

The foundations were fairly simple, all structures going to rock within sheeted pits. Excavation for the west pier was heaviest, averaging 34 ft. below general ground level while on the west side the bottom of the pit was 60 ft. below the top of the slope. A timber bridge was built across the creek to provide access to the lower part of the east abutment.

FIG. 3—STEEL-TRUSS CENTERING in place for two ribs of west arch span. Old steel trestle, moved to one side for use as detour, is in foreground.

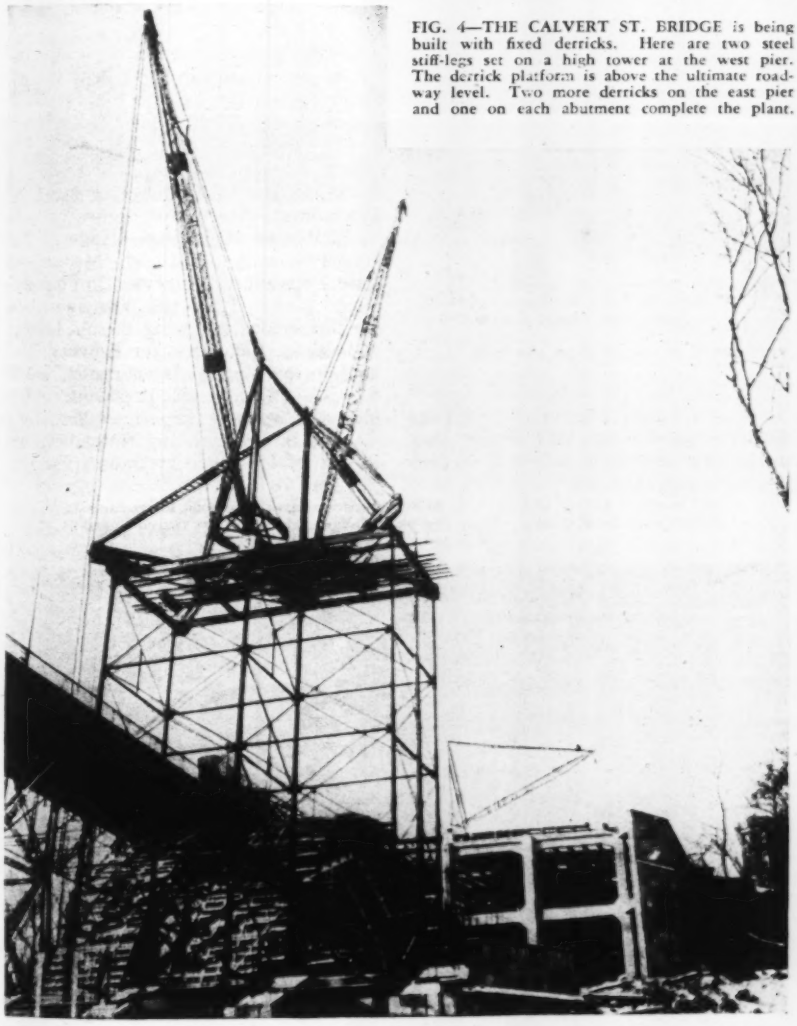


FIG. 4—THE CALVERT ST. BRIDGE is being built with fixed derricks. Here are two steel stiff-legs set on a high tower at the west pier. The derrick platform is above the ultimate roadway level. Two more derricks on the east pier and one on each abutment complete the plant.

Construction procedure

The central portion of the box abutments and the foundations of the piers to spring line of the arches were built first with the aid of crawler cranes. Just enough of the abutment structure was built from foundation to deck by this method, with the cranes working from street level, to support a stiff-leg derrick. From then on the derricks took over the work. Considerable difficulty was encountered at first in the erection of the lattice steel columns in the abutments. These members lacked sufficient rigidity to stand alone. The difficulty was met by strapping 12x12-in. timbers to the columns during erection; these timbers were removed after the stringers and girders had been riveted in place to form a self-supporting framework.

Just below the spring-line level of the piers, steel cross-beams were set to span between the rib supports. Upon these beams were erected the steel towers to carry the derricks. The towers were so designed that none of the tower structure members interfere with the construction of the bridge or come within permanent structure lines.

All derricks are equipped with 100-ft. booms and double-drum electric-drive hoists, with slewing drums. For the two abutment derricks the hoists are at deck level; for those on the towers the hoisting equipment is on the ground some distance from the base of the towers, the operator being signaled by telephone.

The centering for each arch rib consists of a double steel truss. These centers are supported on auxiliary concrete piers, with I-beams spanning over the piers as a track along which the centers can be shifted. There are four sets of centering, two being set up on the west arch (Fig. 3), then shifted to

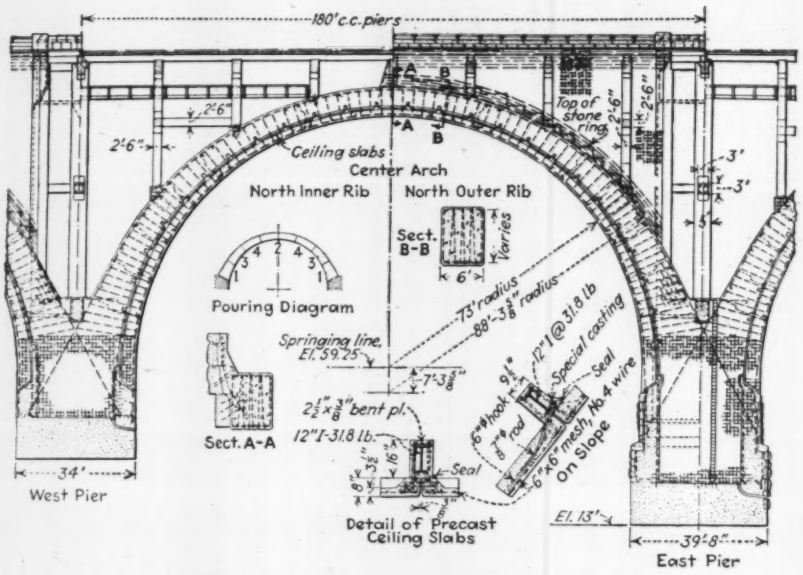


FIG. 5—ARCH RIB and pier details. Inserts show design of suspended soffit slabs and method of fastening in place.

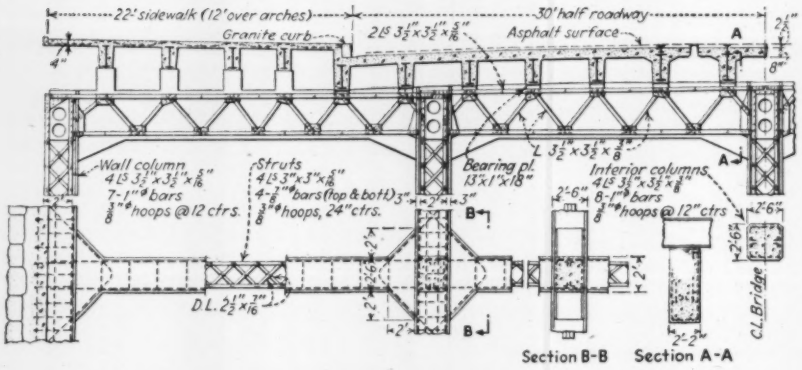


FIG. 6—FRAMING of box abutments. Superstructure of arch spans above ribs is of similar construction.

the other pair of ribs on this span. The other two were set up on the center span. They will be shifted to the other pair of ribs on this span, then moved to the east span, with the construction bridge over the creek being utilized for the move. The steel centers are collapsed by means of jacks and wedges at the lower ends.

Upon the steel trusses are placed timber cross-members carrying curved longitudinal stringers. The rib bottom forms are built upon the stringers, resting on wedges. Plywood is being used for soffits and side forms of the ribs and for other exposed surfaces.

All concrete is delivered in transit mixers, though the water is added to the batch and actual mixing is done at the job under supervision of the inspectors. Concrete trucks can get within reach of all derricks, either on the street at the abutment or on the park driveways below. Concrete is handled by derricks from truck to forms in roller-bottom controllable dump buckets. Flexible spouting is used for the narrow high columns. Specifications for pouring the ribs require that the haunch sections be placed first, then the key, followed by sections next the haunches and then closed next to the keys.

Precast slabs

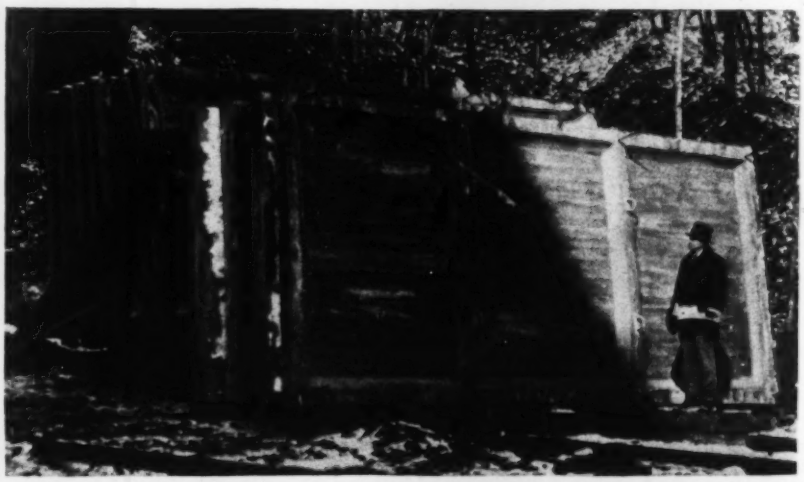
A level spot along one of the park drives was selected as the location of the slab yard. Forms were built for eleven slabs, consisting of timber stringers and beams with smooth lumber sheeting. The slabs are cast bottom or concave side up, with the curved exposed surfaces of the slabs screeded to shape. This method of pouring has resulted in a slab meeting specifications for smooth surface. After the slabs have set sufficiently to permit moving, they are lifted off the forms and stood on edge for further curing (Fig. 7).

A novel method of preventing the thin slabs from freezing while setting has been devised by the contractor. A small tunnel was excavated under the slab platform in which two oil-burning salamanders are placed. Vent tunnels radiating from the main tunnel and holes through the platform between slab forms permit full distribution of heat. Canvas covering over the slabs retains the heat. To retain the moisture in the concrete while setting, large pans of water are placed on the heaters, keeping the hot air saturated during heating.

Direction

The bridge is being built for the board of commissioners, District of Columbia, under the direction of H. C. Whitehurst, director of highways, and C. R. Whyte, engineer of bridges. The design was by Modjeski, Masters & Case, consulting engineers, Philadelphia. Contract for the new structure, which included removing the old bridge, is held by the John W. Cowper Co., Buffalo, N. Y., and Washington, D. C. S. K. Pierce, vice-president, Geo. Herman, general superintendent, and Charles B. Vannier, superintendent, are in charge for the contractor.

FIG. 7—PRECAST SLABS that will be hung between arch ribs at soffit to give appearance of solid barrel arches. These thin slabs, heavily reinforced, are curved to radius of intrados of arch ribs.



Pavement Signs Made Clearer by Asphalt Background

Marks and letters properly sized and shaped and painted on black base (readable 300 ft. away) reduce accidents in St. Louis, Mo., suburb

By James W. O'Hare
Traffic Division, Engineering Department, University City, Mo.

TRAFFIC MARKINGS on the pavement greatly aided the 1934 safety campaign of University City, Mo., a suburb of St. Louis. Every intersection of any importance and all school crossings have been well marked with pedestrian lanes and traffic guide-lines. At all intersections of major streets and at stop intersections on major streets stop signs have been painted on the pavement in letters 8 ft. long and 2 ft. wide (Fig. 2) as an aid to the standard reflecting stop sign at the curb.

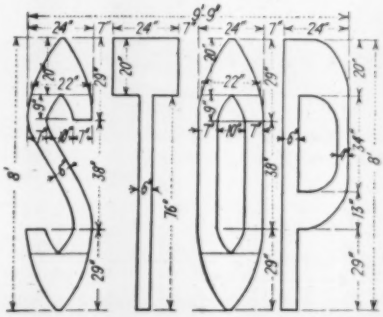
The engineering department of University City for several years has experimented with various ways of marking streets in an endeavor to improve the effectiveness of traffic marking and also to prolong the life of the white paint used for marking. As a result it is believed that this city uses the largest pavement stop sign of any city. The whole sign takes up a space 8 ft. longitudinally by 9¾ ft. in width and is visible as far as 300 ft.

The increase in the size of these stop pavement markings, properly shaded and spaced so as to increase visibility from a distance, was the first real forward step. Then to furnish a contrast for the white stop marking on concrete pavement, there was used as a base a thin layer of black rock asphalt. Tests have shown that the life of paint on rock asphalt is almost twice as long as on concrete. So successful were the results with the stop painted on rock asphalt that the same method was tried for center lines and pedestrian lanes on concrete streets and granite-block rights-of-way for street-cars. This produced a line of greater visibility than any of those in general use.

The method of applying this new line is simple. An intersection is marked out in chalk, the lines being 1 ft. apart. The surface of the 1-ft. area between the chalk lines is then covered with a thin coat of cutback asphalt. The cutback serving as a tack coat is covered with screened rock asphalt, not more than ¼ in. thick after it has been tamped and ironed; this thickness is not enough to cause a jar or bump when cars pass over the line. Irregular edges are trimmed off with sharp steel ice-cutters. This gives a black line 1 ft. wide, which is in itself a distinct traffic line, as a background for a 6-in. white painted line, leaving a 3-in. black margin on each side.

FIG. 1—ROCK-ASPHALT PANEL (left) on which is painted a white "stop" shaded and spaced to give maximum visibility; view 50 ft. away. (Right), white center line 6 in. wide painted on rock-asphalt stripe 1 ft. wide.

FIG. 2—SIZE AND SHAPE of stop-sign letters on pavement for 300-ft. visibility.



The results of this intensive campaign, to show the way to the pedestrians and drivers, are becoming noticeable. The majority of accidents are not at the intersection of major streets where the traffic is heaviest and the streets are well marked, but at secondary streets entering major streets. Traffic is light on secondary streets, and there is absolutely no need of traffic markings on the pavement as there is a standard reflecting major stop street sign at the entrance to the intersection. The police department accident reports show that in practically every case the accident is caused by pure carelessness on the part of the driver entering the major street.

Pedestrian accidents have been reduced from 21 injured and seven killed during 1933 to fourteen injured and one killed during 1934.

This work has the approval of Mayor David L. Miller, who is a member of the St. Louis Safety Council. The idea of the unusual street markings originated with James J. Leahy, superintendent of streets, and the writer, who are in charge of traffic marking. All traffic marking is under the supervision of W. A. Heimbuecher, city engineer.

Water-Wheel Capacity Increased Over 150,000 Hp. in 1934

The total capacity of water wheels at water-power plants in the United States on Jan. 1, 1935, according to the annual report just released by the Department of the Interior through the Geological Survey, was 16,075,307 hp., an increase of 161,856 hp., or more than 1 per cent during the year.

Pennsylvania, with an increase of about 40,000 hp., and West Virginia, with an increase of 140,000 hp., are the only states that show any considerable increase in capacity of water wheels. Some states show a comparatively small increase, and others show a decrease, owing in part to the abandonment of plants and in part to the receipt of more accurate and up-to-date reports.

Engineering in Foreign Countries

Accounts taken from the foreign-language periodicals of important activities in engineering research, design and construction being carried on beyond the United States

TO GIVE the readers of *Engineering News-Record* quick glimpses of engineering activities beyond the United States, it is planned to publish monthly a small group of short abstracts of articles and papers published in other languages than English. In these abstracts no attempt will be made at a compendium of foreign-language articles; selection will be made only of articles that emphasize some procedure or invention in engineering practice that has general interest or usefulness. Selection from each article will also be confined to the part or parts of special novelty or significance—a unique design or construction method or a striking determination by experimentation. For the reader who wishes to have the more extended description or discussions, the author and source of the original article will be given by name and publication dates. The contacts with foreign engineering activities that these summaries and references make possible should have value to American engineers. —EDITOR.

IN REVIEWING electric heating of concrete construction as a means for equalizing employment in the construction industry, G. Kunz, in *Bulletin Technique de la Suisse Romande*, for March 17, 1934, outlines practical methods developed in Sweden and in U.S.S.R.

The practice of electric heating of concrete is based on the facts that freshly deposited concrete is a fair conductor of low-voltage electric current and that ordinary wooden forms act as effective insulation. Electric current is introduced into the concrete mass by means of electrodes consisting of solid plates of sheet iron or of strips of sheet iron, as shown by Fig. 1A. In U.S.S.R. they prefer to use metallic bars of $\frac{3}{8}$- to $\frac{1}{2}$-in. diameter, spaced 18 to 20 in. apart. In standardized construction the strips of sheet iron may be attached to a waterproof canvas fabric which may be unrolled to cover the concrete mass to be heated, as shown by Fig. 1B.

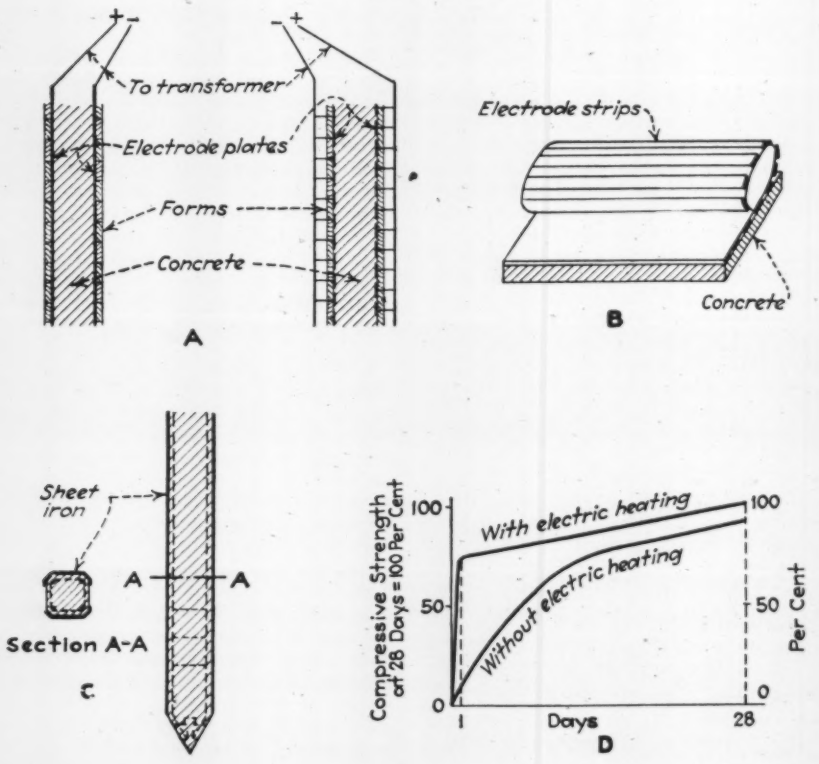
The arrangement shown by Fig. 1C, which was used for heating a precast reinforced-concrete pile, was tested in detail for 24 hours. Within nine hours the temperature of the concrete rose from 64 deg. F. to a maximum of 162 deg. F. near the middle of the pile and 134 deg. F. at its sharp end, after which the current was switched off and the concrete allowed to cool. After 15 hours later, 24 hours after pouring, the corresponding temperatures were 101 deg. F. and 89 deg. F. The forms were then stripped, and the concrete was found to be quite hard. This example, illustrating the progress and distribution of heating in the concrete mass, is not typical as to the temperatures involved; in Russia the method was used successfully at an initial temperature of —4 deg. F.

Theoretically, 0.28 kw.-hr. will raise the temperature of 1 cu.yd. of concrete 1 deg. F.; but in practice, due to imperfect insulation, a greater rate will be required, and for preliminary estimates 0.4 to 0.5 kw.-hr. should be allowed per cubic yard per degree.

Only alternating current can be used, since direct current will electrolyze water. Ordinary voltages of 110 and 220 volts have to be stepped down to 20 to 50 volts. An 8-kw. transformer, weighing about 220 lb., is generally sufficient.

Fig. 1D shows the acceleration of hardening and the increase in compressive strength due to electric heating. Note that strength continues to increase after heating.

FIG. 1—ELECTRIC HEATING METHODS and results in winter concreting in Russia and Sweden.



A highway up Mt. Etna

The rare task of building a highway up the slope of an active volcano is described by O. Priolo, the engineer in charge of construction of the Mt. Etna highway on the island of Sicily, in a quotation published in *Le Strade*, Dec. 1934.

What is presumably the first section of this tourist highway, officially opened on Oct. 21, 1934, starts at Nicolosi, 2,290 ft. above sea level, and terminates at the Alpine Meteoric Observatory, 6,168 ft. above sea level, about 4,570 ft. below the top of the crater whose elevation is 10,740 ft. The total length of this scenic highway is 11.17 miles, which with a total climb of 3,878 ft. allows an average grade of 6.5 per cent. Only 35 per cent of the length of the road is on a grade of 7 to 9 per cent, and 4.6 per cent is on the exceptional grade of 9.5 per cent. Nearly 34 per cent of the road is on curved alignment, with a minimum radius of 98 ft. Immediate reversals of curvature have been allowed only when quite unavoidable, in which cases long radii and entirely unobstructed sights were provided.

Two-thirds of the roadway excavation, totaling 205,000 cu.yd., was in extremely hard lava rock which often blunted the laborers' tools. About 38,000 lb. of powder were consumed for blasting.

The pavement was made of two layers of rolled gravel treated with two coats of cold bituminous emulsion.

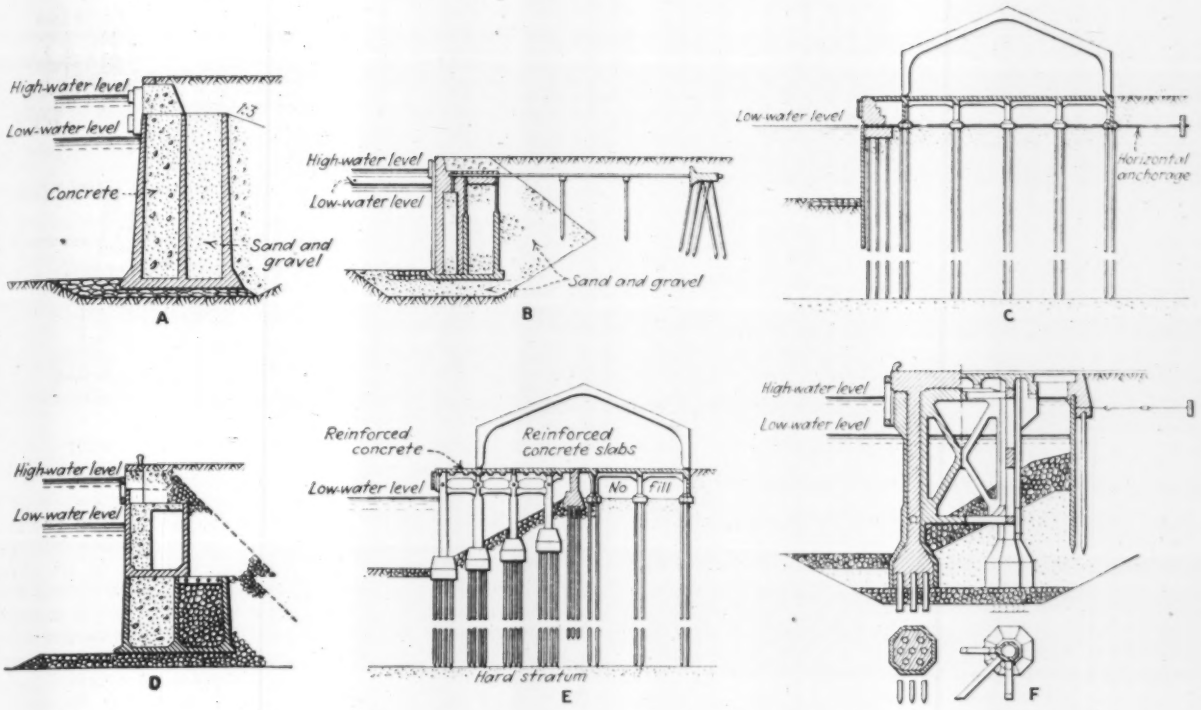


FIG. 2—QUAKE-RESISTING DESIGN in recent quaywall and wharf construction in Japan.

The region is waterless, and retaining walls had to be built of dry-rubble masonry. Drinking water, brought from Nicolosi partly by auto tank and partly on mule back, had to be strictly rationed to the 2,000 laborers used on the job.

The construction took three seasons beginning in April and ending in October, the periods from November to April being entirely unsuitable for construction. The total cost of the highway was 5,400,000 lire.

Japanese quake-resisting marine structures

In reviewing Japanese designs of quaywalls, docks and similar marine structures that have been developed following the disastrous earthquake of Sept. 1, 1923, H. Wegner in *Bautechnik* of March 23, 1934, notes some of the principles and typical methods of resisting earthquake shocks which were embodied in structures recently built in the ports of Tokio, Yokohama, Nagoya, Nagasaki and Shimizu. These designs are most clearly indicated by illustrations.

Fig. 2A shows a quaywall founded on a reinforced-concrete caisson having two compartments, one of which is filled with plain concrete and the other with gravel and sand. In some cases both compartments were filled with gravel and sand, and the walls were braced with horizontal and diagonal struts of reinforced concrete. The base of the caisson is generally widened, in some cases doubling the width of the caisson proper. Fig. 2B illustrates a similar design supplemented with an anchorage resting on a cluster of piles about 100 ft. away. To prevent sagging of the horizontal anchoring bars, they are supported on two sets of piles about 8 in. in diameter. Unreliable ground material was removed and replaced with an artificial fill of sand and gravel.

Fig. 2C features a steel-pile sheeting at the water face of a dock, which is built into the quaywall and is braced with a horizontal anchor at its upper end. Fig. 2D illustrates a Nagasaki quaywall founded on two tiers of reinforced-concrete caissons, one resting on top of the other. This design is criticized on account of the horizontal joint between its two tiers of caissons, which may invite trouble during earthquake tremors.

Fig. 2E shows a landing dock designed in two independent parts, to suit the respective functions of the dock areas, whose columns and footings rest on independent groups of piles driven to a hard stratum, this obviating the effect of lateral earth pressure. Fig. 2F shows Tokio and Yokohama docks founded on a system of hollow reinforced-concrete columns, or polygonal or circular cross-section, braced together both horizontally and diagonally. These hollow columns, which rest on independent groups of piles, were later filled with plain concrete or with sand and gravel. Horizontal anchorage was also provided.

In general, official Japanese instructions for earthquake-resisting design are based on the assumption of a horizontal force due to earthquake shocks equal to one-tenth the weight of the structure. The author argues that earthquake shocks are not of a static but of a dynamic nature, and that earthquake-resisting design should be based on this prime consideration.

World's flattest arch bridge

The so-called Adolf Hitler highway bridge over the Mosel at Koblentz, opened to traffic last April, consists principally of three three-hinged reinforced-concrete arches of the following span lengths: 328, 344.5 and 382.7 ft. The last of these spans, which is of hollow construction, having a rise of 26.6 ft. and a radius of arc of 577.4 ft., has been declared the flattest bridge arch in the world. According to an article by F. Dischinger, in *Zeitschrift des Vereines Deutscher Ingenieure*, June 16, 1934, its nearest rival in flatness is the 594-ft. arch of the Transbergsund bridge at Stockholm, which has a radius of arc of 511.3 ft.

The total length of the bridge and its approaches is about 3,000 ft. This includes a reinforced-concrete viaduct, about 655 ft. long, with bents spaced about 49 to 52 ft. apart. The bridge, which is to carry two rapid-transit tracks, has a roadway 39.4 ft. wide plus two sidewalks, each 9.8 ft. wide, making a total width of 59 ft. The live load is 7,150 lb. per foot.

The bridge crosses the stream at an angle of 70 deg., but its piers had to be set parallel to the axis of the stream. This increased the difficulties of design and construction, as it necessitated the construction of each arch as twin ribs, 21.7 ft. wide, 6.2 ft. apart, and offsetting them longitudinally by 10.1 ft.

To equalize the horizontal thrusts of

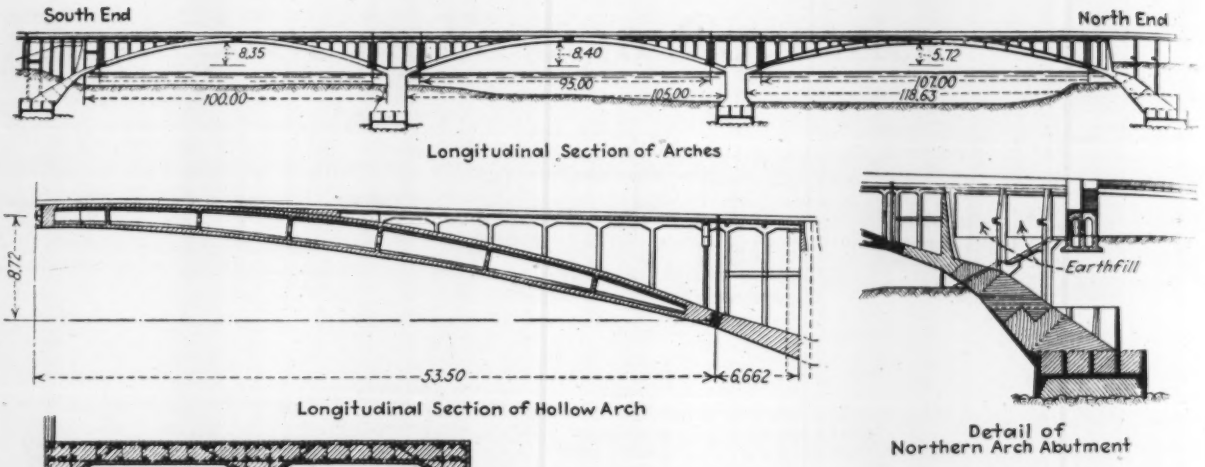


FIG. 3—FLAT-ARCH BRIDGE for highway travel across the Mosel at Coblentz, Germany.

the three arches, the longest one, at the northern abutment, was designed as a hollow cellular member, while the other two were made solid. The thickness of the solid arches is 5.6 and 6.1 ft. at the quarter points and 3.6 and 4.0 ft. at the hinges. The maximum thickness of the hollow arch is 8.4 ft. Maximum stresses in the solid arches are 996 lb. per sq.in., while in the hollow arch each section throughout its haunches is stressed to a maximum of 1,280 lb. per sq.in. which is the limit set by the standardization committee of Germany (DIN). The longitudinal reinforcement of the hollow arch averages 1 per cent of its cross-sectional area. The hollow arch has a live-load factor of safety of six, the solid arches have a similar factor of three.

The four foundations for the three arches were founded on bedrock, about 60 ft. below high-water level, by the pneumatic-caisson method. The maximum pressure allowed on rock was 213 lb. per sq.in. All piers have cantilever arms, 16 ft. or more in length, offering skewbacks to the abutting arches. The northern abutment pier, which is 40.5 ft. wide, has an unusually long cantilever arm, 88.3 ft., as measured from the center of its foundation.

The construction of this bridge took over 26 months; the total cost was 2,950,000 marks.

Penstock under 5,741-ft. head

The twin-pipe penstock of the Chandoline hydro-electric power plant in Switzerland will operate under a maximum static head of 5,741 ft. according to an article by G. Dupont in *Travaux*, October, 1934. This is far above the 2,483-ft. head of the Mese penstock in Italy, which is the present record holder on this class of pressure conduits.

The penstock, which is in its initial stage of construction, starts from a concrete-lined power tunnel, 7.4 ft. in diameter, about 39,000 ft. long, leading from a storage reservoir formed by a dam 262 ft. high, impounding Dixence Creek in the basin of the Upper Rhone. It consists of two welded steel pipes, each 17,966 ft. long, varying in diameter from 55½ to 38¾ in., designed to carry a total flow of 362 cu.ft. per second, with a velocity of 10.5 to 22.3 ft. per second.

FIG. 5—SCHEME OF TEST of resistance of high-head penstock pipe against internal pressure.

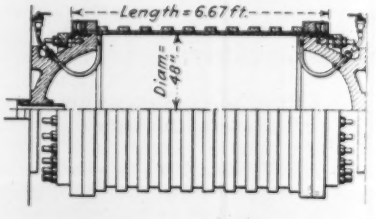
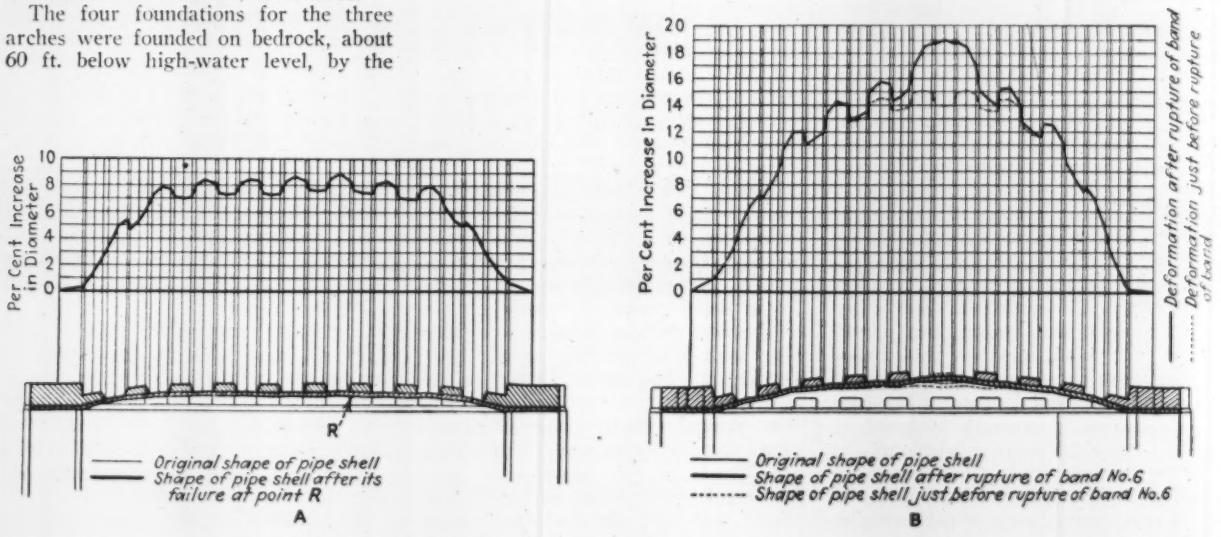


FIG. 4—RADIAL deformation of high-head penstock pipe, (A) after failure of shell, and (B) after failure of band.



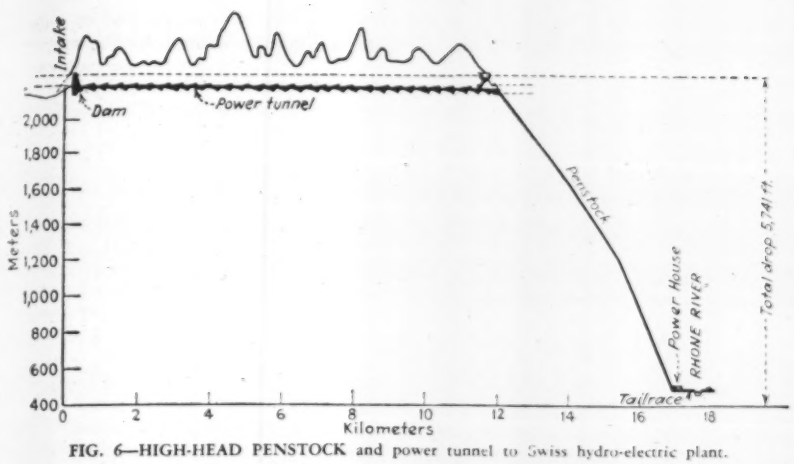


FIG. 6—HIGH-HEAD PENSTOCK and power tunnel to Swiss hydro-electric plant.

at a maximum pressure of 2,418 lb. per sq.in.

The upper 5,217 ft. of the penstock, 55½ to 44 in. in diameter, will be all welded, and its thickness will vary from ⅜ to 1 1/16 in. The remaining 12,749 ft., with diameters ranging from 47 to 33½ in. and a thickness of 1⅛ to 3⅛ in., will have 1,600 transverse electrically welded joints and will be reinforced with heavy circular bands or hoops. The total job will require 17,600 tons of steel.

The materials for a pipe of this magnitude and unprecedented stresses had to be subjected to most elaborate mechanical tests and chemical analyses, the results of which were as shown in the following figures:

ANALYSIS OF STEEL

	Per Cent Pipe Shell	Bands
Carbon	0.085	0.24
Manganese	0.492	0.83
Silicon	0.000	0.23
Sulfur	0.440	0.22
Phosphorus	0.016	0.02

MECHANICAL TESTS OF STEEL

	Pipe Shell	Bands
Resistance to rupture, lb./sq.in.	49,070–49,210	77,900–98,500
Elastic limit	32,290–33,570	52,060–52,480
Elongation %	23.8–29.0	22.90–24.25
Contraction %	64.0–66.0	53.5–59.0
Resilience, lb./sq.in.	165.0–266.0	121–174

Additional resilience tests were made on 162 specimens taken from the exterior, interior and central layers of a pipe shell element after the manufacture of the pipe. Welds are specified to have a minimum of 90 per cent of the strength of the adjacent steel, and tests have shown that this strength may be safely expected.

It was impossible to provide equipment powerful enough to test full-size pipe sections under the maximum pressures, which are expected to reach about 2,500 lb. per sq.in., so two banded pipe segments, practically 48 in. in diameter, each 6.67 ft. long, designed for a pressure of only 403 lb. per sq.in., were tested to failure, with the following results: one pipe failed at a welded seam, having attained a maximum diameter of 52.1 in. under a pressure of 3,485 lb. per sq.in., indicating a factor of safety of 4.4. The other pipe failed through rupture of one of its reinforcing bands after attaining a maximum diameter of 55.2 in. under a pressure of 3,584 lb. per sq.in. or a factor of safety of 4.8.

Sludge-Elutriation Tests Establish Cost Figures

Experiments at Baltimore show that the greatest saving in cost of vacuum filtration will obtain when digested sludge is elutriated with seven or eight volumes of water—Cost will then be $2.94 per ton of dry solids

By C. E. Keefer and Herman Kratz, Jr.
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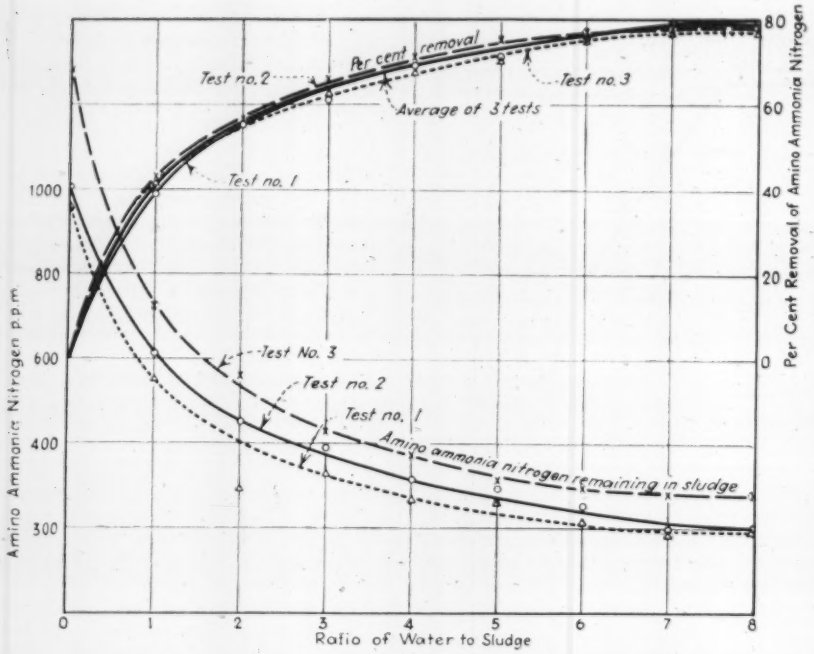
A SERIES of field experiments conducted at the Baltimore sewage works during 1933 and 1934 (see *Sewage-Works Journal*, September, 1934) indicated the desirability of elutriating digested sludge prior to dewatering by vacuum filtration. By using this process the quantity of coagulant needed to flocculate sludge can be greatly reduced with a considerable saving in cost. Estimates based on this investigation indicated that when digested sludge was elutriated in the ratio of one volume of sludge to two volumes of water, coagulated with ferric chloride and then filtered, the total cost of dewatering would amount to about $3.38 per ton of dry solids. At that time sufficient information was not available to indicate how much elutriating water should be used to get the most economical results. Since then this question has been investigated. These studies show that for Baltimore conditions filtration costs are lowest when one volume of sludge is elurtiated with 7 to 8 volumes of water. When this amount of water is used, it is estimated that the cost of sludge dewatering will be $2.94 per ton of dry solids.

The elutriation process as applied to the treatment of digested sludge prior to filtration consists of thoroughly mixing water or the effluent from a sewage works with the sludge for a few minutes, allowing the solids to settle and removing the supernatant liquid. The settled material is then ready to be coagulated and filtered. By adding water to digested sludge certain soluble ammoniacal decomposition products such as amides, amines, amino acids and ammonium carbonate and bicarbonate, measured in terms of nitrogen and called amino ammonia nitrogen in this article, diffuse into the water and their concentration in the sludge becomes less. As these compounds enter into chemical combination with ferric chloride and other similar coagulants, their partial removal will reduce the quantity of coagulant required. The elutriation process, therefore, is an effective way of removing the amino acids and ammoniacal products. Digested sludge contains from 700 to 1,200 p.p.m. of these compounds before elutriation and as low as 200 to 250 p.p.m. after elutriation.

The experiments to be described consisted of determining to what extent the amino ammonia nitrogen in the sludge was reduced as the volume of elutriating water was increased. Three groups of tests were made, the first being in the field and the other two in the laboratory. The field test consisted of transferring about 1,600 gal. of ripe sludge, which contained 6.4 per cent solids and 53.0 per cent volatile matter, from a heated digestion tank itno a large steel container. From here about 1,100 lb. of the material was run into another tank to which a known volume



AMINO AMMONIA NITROGEN removed from digested sludge when elutriated with various quantities of water.

of clean water was added. The water and the sludge were thoroughly stirred by means of motor-operated paddles for 5 min. The mixture was then allowed to settle for 22 hours, after which the supernatant liquid, or elutriate, was run off. Samples of the elutriate and the sludge before and after elutriation were collected for analysis. The ratio of elutriating water to sludge was varied from one to eight.

The two laboratory tests were made in the same general manner as the field investigation except that the work was on a much smaller scale. A quantity of ripe sludge from the same digestion tank was used. A 1-liter portion was put into a 5-gal. carboy and mixed with a predetermined amount of water. The two liquids were thoroughly shaken for 1 to 2 min., and then allowed to stand for 22 hours. The elutriate was siphoned off, and samples of the materials were obtained for analysis. The test was then repeated with larger volumes of water.

The analyses of the sludge used during the three tests both before and after elutriation are given in Table I. In the field test the amino ammonia nitrogen was gradually reduced by the use of larger and larger volumes of water from 881 p.p.m. in the unelutriated material to 196 p.p.m. when 8 volumes of water to 1 of sludge were used. The solid content of the elutriated sludge varied from 6.0 to 7.0 p.p.m., with an average of 6.5 p.p.m., which was practically the same as that of the unelutriated material.

In the two laboratory experiments the amino ammonia nitrogen in test No. 2 was reduced from 1,009 to 199 p.p.m., and in test No. 3 from 1,280 to 280 p.p.m. In test No. 2 the solid content of the elutriated sludge averaged 7.6 p.p.m. as compared with 7.5 p.p.m. in the unelutriated material. The concentration of solids in test No. 3, which averaged 7.5 p.p.m., was less after elutriation than before.

With the exception of the results obtained during test No. 1 there was a reduction in volatile matter in the elutriated sludges. This reduction was undoubtedly due to the removal of soluble nitrogenous compounds by the elutriating water. Furthermore, the removal of these compounds, principally in the form of ammonia, caused a lowering of the pH value.

The character of the elutriate is of special significance, as it normally would have to be treated. Table II gives the analyses of the elutriates during each of the three tests. In test No. 1 the five-day B.O.D. of the elutriate decreased from 232 p.p.m. when 1 volume of sludge was elutriated with 1 volume of water to 52 p.p.m. when 8 volumes of water were used. All of these elutriates are weaker than the raw sewage at Baltimore, which has a five-day B.O.D. (1933 average) of 249 p.p.m. The elutriate can, therefore, be added to the raw sewage without increasing the strength of the latter. The average of the suspended solids of all of the tests was 193 p.p.m., which compared favorably with a suspended solid content of 175 p.p.m. (1933 average) in the raw sewage.

Cost estimates

The ultimate purpose of sludge elutriation is to reduce the amount of coagulant needed to flocculate the solids and thus decrease the cost of sludge dewatering. Experiments have indicated that the saving in coagulant is directly proportioned to the reduction in amino ammonia nitrogen. For example, by decreasing the concentration of ammoniacal decomposition products 50 per cent, a corresponding saving of 50 per

TABEL I—ANALYSES OF ELUTRIATED SLUDGE

Ratio of Elutriating Water to Sludge	Test No. 1 (Field) Amino Ammonia Nitrogen, P.P.M.	Solids, Per Cent	Volatile Matter, Per Cent	pH	Test No. 2 (Laboratory) Am. Am. Nitr., P.P.M.	Solids, Per Cent	Vol. Mat. Per Cent	pH	Test No. 3 (Laboratory) Am. Am. Nitr., P.P.M.	Solids, Per Cent	Vol. Mat. Per Cent	pH
No water used....	881	6.4	53.0	7.4	1,009	7.4	51.1	8.0	1,280	8.5	51.1	7.3
1.....	546	7.0	53.6	7.5	616	6.8	50.8	7.3	728	6.9	51.3	7.5
2.....	288	6.7	55.2	7.5	451	8.1	49.7	7.2	560	7.7	50.9	7.3
3.....	330	6.6	53.7	7.0	391	8.5	49.4	7.1	430	7.3	50.9	7.2
4.....	270	6.4	54.2	7.0	315	7.9	49.3	7.1	373	7.7	50.5	7.1
5.....	260	6.6	54.2	7.4	295	7.3	49.9	7.0	316	7.6	50.2	6.9
6.....	218	6.0	55.8	7.4	253	7.2	49.9	7.0	295	7.4	50.3	6.9
7.....	186	6.2	55.1	7.1	196	7.3	49.6	6.9	280	7.6	51.5	6.8
8.....	196	6.7	55.0	7.1	199	7.3	50.1	6.9	280	8.0	50.6	6.9

TABLE II—ANALYSES OF ELUTRIATE

Ratio of Elutriating Water to Sludge	Test No. 1 (Field) 5-day B.O.D. 20 deg. C., P.P.M.	Test No. 1 (Field) Suspended Solids, P.P.M.	Test 2 (Lab.) Susp. Solids, P.P.M.	Test 3 (Lab.) Susp. Solids, P.P.M.
1.....	232	166	146	292
2.....	164	298	225	308
3.....	142	284	155	244
4.....	94	214	86	116
5.....	116	228	124	276
6.....	107	216	134	196
7.....	82	202	140	137
8.....	52	188	93	156

TABLE III—FERRIC CHLORIDE NEEDED TO COAGULATE ELUTRIATED SLUDGE CONTAINING 36½ TONS OF DRY SOLIDS DAILY

Ratio Elutriating Water To Sludge	Saving of $FeCl_3$ by Elutriating Sludge, Per Cent	$FeCl_3$ Required: Unit Quantity, Lb. per 100 Lb. Dry Solids	$FeCl_3$ Required: Yearly Lb.	Cost of $FeCl_3$*
0	0	5.25	1,149,750	$25,295
1	41.7	3.06	670,140	14,743
2	55.8	2.32	508,080	11,178
3	63.6	1.91	418,290	9,202
4	68.8	1.64	359,160	7,902
5	72.7	1.43	313,170	6,890
6	75.8	1.27	278,130	6,119
7	78.0	1.16	254,040	5,589
8	79.2	1.09	238,710	5,252

*$FeCl_3$ is assumed to cost 2.2c. per lb.

TABLE IV—YEARLY COST OF FILTERING SLUDGE ELUTRIATED WITH VARIOUS VOLUMES OF WATER

Ratio of Elutriating Water to Sludge	Total Cost of Filter Installation	Fixed Costs: Interest on Investment at 4%	Fixed Costs: Depreciation	Fixed Costs: Total Fixed Costs	Operating Costs	Total Costs	Cost per Ton of Dry Solids
0	$129,400	$5,176	$6,750	$11,926	$36,574	$48,500	$4.43
1	135,800	5,432	6,800	12,232	27,168	39,400	3.60
2	139,000	5,560	6,830	12,390	23,710	36,100	3.30
3	142,300	5,692	6,860	12,552	21,948	34,500	3.15
4	145,500	5,820	6,890	12,710	20,790	33,500	3.06
5	148,700	5,948	6,920	12,868	19,932	32,800	3.00
6	151,900	6,076	6,950	13,026	19,374	32,400	2.96
7	155,100	6,204	6,970	13,174	19,026	32,200	2.94
8	158,400	6,336	7,000	13,336	18,864	32,200	2.94

cent in coagulant can be expected. Based on this information, estimates have been prepared on the cost of dewatering the digested sludge produced at Baltimore when using various quantities of elutriating water.

These estimates are based on filtering digested sludge containing 36½ tons of dry solids daily. An installation consisting of four 350-sq.ft. filters together with all the necessary auxiliary equipment housed in a suitable building has been estimated. Table III gives the quantity and the cost of ferric chloride required for coagulating purposes. Unelutriated sludge has been assumed to require 5¼ lb. of ferric chloride per 100 lb. of dry solids in the sludge, to produce a cake containing 6.8 lb. of dry solids per square foot of filter area per hour. When this quantity is used, the total yearly cost of the coagulant amounts to $25,295. By elutriating 1 volume of sludge wtih 8 volumes of water only 1.09 lb. of ferric chloride per 100 lb. of dry solids is required at a yearly cost of $5,252. Thus, the saving in coagulant would be a little over $20,000 annually.

However, if large amounts of elutriate are used, bigger elutriating tanks would be required. The fixed costs on these larger units would somewhat offset the saving in ferric chloride. Furthermore, at Baltimore there would be the added cost of pumping the elutriate into the raw sewage. A summary (Table IV) is given of the fixed and operating costs of sludge filtration when elutriating Baltimore sludge with various volumes of water. When the sludge is not elutriated, the total yearly cost is $48,500, or $4.43 per ton of dry solids. These costs become $36,100 and $3.30 respectively when 1 volume of sludge is elutriated with 2 volumes of water. The most economical results are obtained when 7 or 8 volumes of elutriating water are used. Then the annual cost of sludge filtration is $32,000, or $2.94 per ton of dry solids.

The sewage-works is under the general control of B. L. Crozier, chief engineer, department of public works, and George E. Finck, sewerage engineer, with G. K. Armeling as superintendent and Edward C. Cromwell as principal sanitary chemist. Acknowledgments are due to J. W. Bushman, junior chemist, who assisted in the field and laboratory work.

New Paving-Brick Technique Developing with Research

National Paving Brick Association marks annual meeting with a presentation of notable research data on joint filler and cushion-course materials and on de-aired brick

DEFINITELY new information on de-aired brick and on joint fillers and bedding material for brick pavement was presented at the annual meeting of the National Paving Brick Association in Indianapolis, Ind., on Feb. 6-8. In general, it was indicated that an approach had been made by experimentation to positive definition of joint filler and bedding-course compositions. The conclusions on de-aired brick were that production technology and the physical characteristics of the new brick were not yet well enough determined to justify its recommendation as a standard product. Different raw materials, it had been found, reacted differently to the de-airing process, and until the factories had each solved the problem of its raw material and could guarantee a standard product and also until more factories were equipped for de-airing, it seemed premature to make any recommendations.

During the year the association undertook research in a positive way by establishing a research bureau at Ohio State University under the direction of Dr. W. C. Rueckel. The report of this bureau was one of the important technical contributions of the meeting. Research sponsored by the association was also undertaken by Hugh Skidmore, of the Chicago Testing Laboratory, on bituminous bedding-course mixtures. The report on this study was made by P. E. Sundstrom, Illinois regional engineer of the association.

Study of bedding materials

The immediate reason for a laboratory study of cushion-course material arose from the experience of the Illinois highway department in its program of widening some of its concrete roads and resurfacing them with brick. It was found that the cushion material used, which was 5 to 8 per cent asphalt or tar cutback and 95 to 92 per cent of torpedo sand, was not bridging but was dropping into the bare cracks, with a resulting local settlement of the brick surface. Study was first made of the faulty cushions by uncovering the brick in various places. In all cases the cushion was soaking wet and was badly emulsified, with the bitumen largely removed. Analysis showed only 2 per cent or less of bitumen remaining, not enough evidently to bond the sand particles. Clearly, the use of cutback material did not provide enough bitumen to make a real binder; and even if it did provide enough bitumen, the volatile solvents could not evaporate when covered with the sealed brick surface. Also it was clear that any mixture with too little bitumen either to waterproof or to bond the mineral was certain to disintegrate from the moisture constantly present in a concrete base.

In searching for a better material it appeared that the direction should be toward (1) a simple composition that contractors could produce on the job without elaborate equipment, (2) ample bitumen content to insure good bond and thick waterproofing films, (3) a material that could be laid cold, (4) a composition in which setting up or bond would be rapid, and (5) a material having the characteristics of common bituminous paving mixtures. Consideration indicated that the greatest possibilities were offered by a powdered hard asphalt and a suitable flux.

Some 27 such mixtures were tried, and of them five were selected for study in full. From the full study a specification was prepared that called for a mixture of 88 to 90 per cent mineral aggregate, 4 to 5½ per cent powdered asphalt and 5½ to 7½ per cent of flux. The aggregate, asphalt and flux are specified, but the full specifications are omitted as the purpose here is only to indicate in a

general way the character of bedding mixture arrived at—briefly, a torpedo sand with a bitumen content of 10 to 12 per cent. This mixture, it was asserted, can be produced with simple equipment in a few minutes, is workable long enough to be laid and surfaced without haste, will stabilize in 24 to 48 hours covered or uncovered, and from the first will, when weighted with paving brick, span ¼ to ½ in. cracks and will not crowd up between the bricks when rolled.

The specifications developed will be tried out by the Illinois highway department on its resurfacing operations in 1935. From a study of costs it is concluded that the use of the new mixture will increase the cost about $1 a ton as compared with the cutback asphalt mixture that has been used.

Exuding of asphalt fillers

The experiments of Dr. Rueckel on joint filler material, while leading to no definite recommendations, did bring out rather clear indications of possible improved bituminous compounds and pointed rather clearly to the merits of a plastic sulphur. A survey of many Ohio roads for exuding filler disclosed (1) that the average of brick surface covered by asphalt which had exuded was about 25 per cent; the extremes noted were 20 and 45 per cent; (2) no proof was obtained of the theory that fast-moving pneumatic-tire traffic pulls the filler from the joints; (3) there was less exuding from longitudinal joints when beveled-end bricks were used; and (4) quality of filler showed great lack of uniformity.

As a basis for laboratory investigation, it was assumed that the factors affecting the exuding of filler were: (1) thermal expansion of the filler, (2) thermal expansion of the brick, (3) movement of filler due to its fluidity in hot weather and (4) movement of the brick. On the assumption also that sources of crude oil and methods of refining to produce asphalt had an effect on exuding, it was decided to study asphalts from different sources and of various blends.

A series of tests to determine the linear coefficient of thermal expansion disclosed a value of 116 for semi-asphaltic base-oil asphalt and of 80 for asphaltic base oil. For shale paving-brick the coefficient was 3.4, so that the ratio of the coefficient of asphalt and brick is about 35:1. In ordinary pavement the volume of asphalt and brick is in the ratio of about 1:10. These values indicate the importance of thin joints and very hot asphalt in the reduction of exuding. It is noted here for attention later that the thermal-expansion tests gave a value of 8.3 for plastic sulphur.

EXUDING JOINT FILLER, characteristic of many brick pavements.

Tests were then made on 1-yd.-square sections of brick laid on a sand cushion on a concrete base using different joint fillers. The squares were bound tight by forms on four sides and were heated by electric strip heaters in a metal hood placed over the forms. The temperature thermostatically controlled was raised to 125-130 deg., held there for a definite time, and then the test panel was allowed to cool. Considering asphaltic fillers, some of the results obtained were as follows:

1. Comparing an asphaltic-base and a semi-asphaltic-base oil asphalt filler, three days' heating produced greater exuding of the semi-asphaltic base-oil asphalt filler. Both fillers were poured at 410 deg.

2. Pouring the filler at the lower temperature of 350 deg. increased exuding.

3. Of various mineral admixtures to semi-asphaltic base-oil asphalt, the best results were had with an addition of 33 per cent of sand between 20 and 28 mesh; exuding was less than with any other mixture.

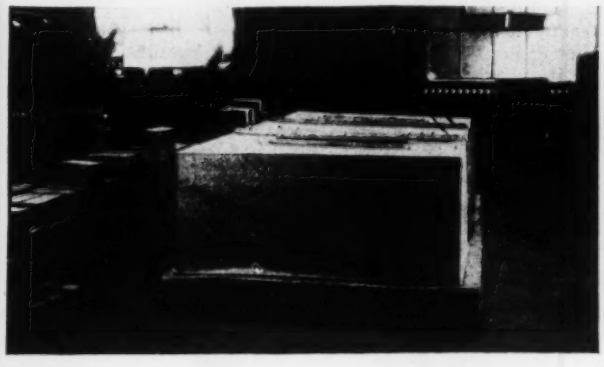
4. A blend of 65 per cent semi-asphaltic base and 35 per cent asphaltic base-oil asphalt was found far superior to all other asphalts or mastic mixtures tested.

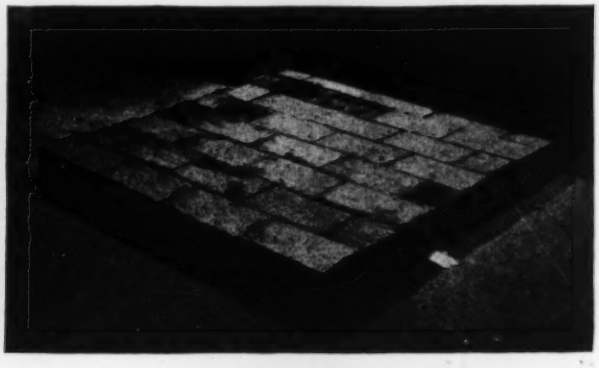
Plastic sulphur filler

Contact with the work at Mellon Institute in developing plastic sulphur indicated a test of that material as joint filler. Several compounds were tested, and one proved highly satisfactory, being waterproof and flexible, and showing a low coefficient of thermal expansion, resistance to exuding and ease of application. Based on the panel tests and also on a test section of road, the following facts were cited: The excess plastic sulphur can be removed as is asphalt by spraying the brick before filling with a calcium chloride solution. The fluidity of plastic sulphur at its application temperature (about 300 deg.) is much greater than that of heated asphalt. The width of the joints can therefore be reduced and the saving in material made to balance the greater cost per unit of volume as compared with asphalt. More caution has to be used in heating, as plastic sulphur decomposes when heated above 350 deg.; an oil-bath heating kettle is indicated. The filler is also stiffer and harder to cut than asphalt when removing it from the brick surface.

Intrusion of joints by remover

Another part of the investigation of joint filler concerned the possibility of weakened bond due to penetration into the joints of the separating agent used for removing excess filler from the brick surface. Brick taken from a road that had been coated by spraying showed that in many cases the filler adhered to the brick only for part of the depth of the joint. Laboratory tests of the filler showed a loss in ductility at 25 deg. C. from 5 to 3½ and in penetration from 34 to 26. An analysis of the filler





METAL HOOD with electric strip heaters used to determine the exuding of joint filler (left), and typical panel of pavement arranged for exuding test (right).

showed a small content of calcium, which evidently had its source in the calcium chloride solution with which the brick had been sprayed. These results led Dr. Rueckel to suggest that methods of applying the remover other than spraying should be investigated. He had, he said, found by laboratory tests that a sponge rubber roller offered promise; it did away entirely with joint penetration by the remover fluid.

Strength tests

Recent breakage of brick in pavement, said Dr. Rueckel, had been of enough concern to warrant a study of transverse strength and perhaps a requirement in specifications for transverse strength as well as for the routine rattler test. So far, tests had been made giving the results shown in the accompanying table,

TRANSVERSE STRENGTH AND RATTLER LOSSES OF PAVING BRICK FROM TWELVE OHIO PLANTS

1	2	3	4	5	6
1492	1715	1927	1711	1533	17.71
1746	1656	1852	1751	1619	26.75
19438	1165	1202	1268	1209	20.62
2138	2726	2958	2607	2923	15.74
2310	2426	2664	2366	2736	20.20
2021	....	2190	2105	2951	22.25
2380	2445	2448	2424	2223	19.64
2284	2600	2655	2498	2495	21.63
2680	3826	3980	3495	3241	26.55
1977	2194	2098	2089	2151	18.90
2285	2811	3029	2708	2499	19.65
2588	2671	3004	2754	2930	20.83

1. Average strength of 10 light-burn specimens. (Brick Research Bureau.)
2. Average strength of 10 medium-burn specimens. (Brick Research Bureau.)
3. Average strength of 10 dark-burn specimens. (Brick Research Bureau.)
4. Average value for 30 specimens in Cols. 1, 2 and 3.
5. Flexure-test values. (Ohio State Highway Testing Laboratory.)
6. Rattler-test values. (Ohio State Highway Testing Laboratory.)

which is given in full because transverse strength test results on recent paving brick are rather scarce. Commenting on the results so far obtained, Dr. Rueckel said:

The tabulated test results indicate that with one exception brick from all plants cooperating can meet a specification for transverse strength of 1,500 lb. per sq.in. This figure has been tentatively considered until such time as it is possible to expand the tests on Ohio brick to include those of crushing and absorption. These further tests will permit drawing up a more definite specification for transverse strength, as so far in the tests there is no apparent correlation between rattler loss and transverse strength. However, it has been noted that increased resistance to breakage can be obtained by firing the brick harder, though in most cases this means increased rattler loss.

De-aired paving brick

In announcing the subject of the full session devoted to de-aired brick Dr. G. A. Bole, Ohio State University, expressed the opinion that no improvement of recent years in a paving material ranked in technical importance with the development of de-aired brick. The program scheduled five major papers, all but one relating to manufacturing technology and factory problems. The important paper to paving engineers and perhaps the best that has been written for his purposes was "Physical Properties of De-aired Paving Brick" by R. B. Keplinger, Metropolitan Paving Brick Co., Canton, Ohio. This paper will be published soon in these pages.

Canadian Engineers Discuss National Problems

Engineering Institute of Canada meeting in Toronto devoted largely to question of consolidation of the profession in Canada, to civil service and to professional problems—Drought and water supply in Prairies considered

FEATURED BY an increasing attention to broad public questions rather than to the minutiæ of engineering design, the 49th annual meeting of the Engineering Institute of Canada was held in Toronto Feb. 7-8. One general session was devoted to consideration of the status of the engineer, and by general agreement discussion of this subject was linked with renewed discussion of the organization of the profession in the Dominion. The last afternoon session was devoted to a symposium of papers on the drought problem of the Prairie provinces, prepared by engineers, geologists and meteorologists; international in scope, this feature of the program was by general admission one of the most important staged in Canadian civil engineering circles for many years.

Frederick A. Gaby, late chief engineer of the Hydro-Electric Power Commission of Ontario, was elected president, as noted in *ENR*, Feb. 14, p. 265. E. V. Caton, of Winnipeg, and P. L. Pratley, of Montreal, were elected new vice-presidents for two of the five zones into which the Institute divides the Dominion. Mr. Gaby referred to the fact that his election had not been unanimous, but solicited general support during his term of office, which was cordially assured by the meeting. Suggestions that his election had any political significance were categorically denied, outside the meeting, by officials of the Institute.

The Sir John Kennedy medal, highest award of the Institute, was awarded to R. A. Ross, of Montreal, past president; the Gzowski medal to W. H. Powell, of Vancouver; the Plummer medal to F. A. Lathe, of Ottawa; the Leonnard Gold medal to D. E. Keeler; and junior and student awards, the John Galbraith Prize, and the Phelps Johnston Prize, to F. A. Masse, Jr., and G. B. Charlewood respectively.

Among visitors to the meeting was George B. Seabury, secretary of the American Society of Civil Engineers, who conveyed greetings from this sister society, and the Honorable Grote Stirling, a member of the Institute and Canada's first engineer cabinet minister, who presented the prizes and medals at the annual dinner. Dean A. S. Eve, of McGill University, speaking at the annual dinner, analyzed existing economic ills, and called for a simpler and more direct approach to current problems.

Institute affairs

Reports showed the society to be in a satisfactory financial position. Membership statistics were not so satisfactory; admissions have increased slightly, but more than 400 members have been placed on the non-active list during the past year, this list now standing at 609. Total membership, active and non-active, is now 4,373 compared with 4,407 one year ago. Unemployment among Institute membership was stated to have improved greatly, the problem having disappeared in many centers. In discussion it was brought out very forcibly that this is no true picture, many younger men not having joined the Institute, as they would have done in normal times, due to unemployment in engineering, or even in any line of work at all. It was mentioned that in Winnipeg, for example, these young trained engineers have banded themselves into a small organization of their own.

F. P. Shearwood, retiring president, devoted his address to a review of structural engineering, and in particular to steel structure design and fabrication, with which work he has been associated for almost half a century. Mr. Shearwood now is chief engineer of Dominion Bridge Co. He made a strong plea for modification of orthodox design methods in the light of experience, old bridge designs that contravene many modern standard requirements being cited as examples. He suggested especially that allowance should be made in bridge designs

for stress distribution by secondary distortion due to the ductility of steel, a property generally neglected. The revolution in design and fabrication initiated by the introduction of welding and cutting-torch practice was referred to, and a plea was made for more consideration to the esthetics of design.

Consolidation

The general business session closed with a discussion which followed the reading of resolutions and similar communications received from the Ottawa, Quebec, Montreal, Border City and Regina branches of the Institute, together with one from the Association of Professional Engineers of New Brunswick, all advocating immediate action toward the consolidation of the profession in Canada. Existing duplication between the Engineering Institute of Canada, the Dominion-wide voluntary body, and the various provincial associations of professional engineers, solely legal bodies which developed out of the Institute about 1920 (following recognition of the fact that under the British North America Act any legislation for the profession must be provincial in scope), has been generally felt to be a deterrent to the rightful advance of the Institute and of the engineering profession in Canada.

Correlation of these diverse interests has been considered by several committees during the past ten years, but no appreciable progress has yet been recorded, although the educational work done by these committees is now being felt. A suggested plan for consolidation of the Institute and the provincial bodies was therefore submitted to the meeting, as had been done to the Montreal branch previously, by Gordon McL. Pitts, of Montreal. This was discussed, and the meeting went on record first as favoring the general principle of consolidation of the several bodies as the ultimate solution to present difficulties. After further discussion, a committee of five, with power to add to its number, representative of all grades of membership of the Institute, was appointed to investigate the whole question of consolidation anew during the coming year.

Status of the engineer

The general discussion on "The Status of the Engineer" was introduced by a forceful speech by J. B. Carswell of Hamilton, who suggested that "The *Stature* of the Engineer" would have been a better title. The program of the meeting, which was definitely criticized by the speaker, was instanced as an example of the failure of engineers in Canada to play their proper part in public affairs. He stated that rational housing design, the general state of the construction industry, and even broader economic topics would have been more worthy of discussion by the engineers of the Dominion at their one annual meeting than details of design of no general significance.

Three papers served to introduce the open discussion, the first being a careful analysis of the place of "The Engineer in the Public Service," by G. J. Desbarats, former Deputy Minister of National Defense. The position of the engineer in the service of the federal government was first explained, and the satisfactory working of the Civil Service Act was commented on, since under this act the position of engineers, as of other civil servants, is protected—political influence being eradicated. The engineer employed by provincial governments and by municipal administrations is not so fortunate, since provincial and municipal civil service acts are either incomplete or entirely lacking, with consequent political interference. Ward politics in city administration were recognized as a grave danger. After the discussion, a resolution was adopted calling on the council of the Institute to prepare a suitable recommendation for the general adoption of rigid civil service acts for engineering and other services to be forwarded to all provincial governments.

The engineer in private practice was dealt with in a paper by J. M. Oxley, of Toronto, relationship with the sister profession of architecture being one aspect of the subject that was specially stressed. Responsibility of the consulting engineer for mistakes made in work under his direction proved to be a focal point in discussion, but no general opinion on this point was evident. Finally, "The Engineer and Industry" was discussed in a paper by R. E. Smythe, of Toronto, in which the growing employment of engineers in industrial work was emphasized and illustrated by statistics bearing upon the positions held by engineering graduates from Canadian universities for the four decades of this century. The speaker stressed the serious problem that had arisen during the last ten years through the increased number of branch industrial plants established in Canada (200 in 1920, and 1,300 in 1934) as a direct result of general national policy. Many of these plants did their technical work in their main offices outside of Canada, and this reacted on Canadian costs, besides placing Canadian engineers at a disadvantage. The necessity of dealing with this problem firmly and promptly was a keynote of the paper, and it was echoed in the discussion that followed.

Technical papers

Technical papers included descriptions of the general features of the new $14,000,000 duplicate water-supply system for the city of Toronto, by Wm. Storrie, of Gore, Nasmith and Storrie, joint consultants for the work; details of the design, fabrication, and erection of three recent Canadian bascule bridges of the simple trunnion type, at Winnipeg, Sorel and Gaspé, by H. W. Buzzell, and R. S. Eadie, both of Dominion Bridge Co., Montreal; the research and testing work of the Hydro-Electric Power Commission of Ontario, by W. P. Dobson, chief testing engineer to the commission; and a description of a simple graphical solution for pressure rise in pipe and pump discharge lines, by Prof. R. W. Angus, of the University of Toronto.

Prairie water supply

The last professional session was presided over by S. G. Porter, of the Department of National Resources of the Canadian Pacific Railway, Calgary, and was devoted to a consideration of the "Water Supply of the Prairie Provinces" and its bearing on their economic development. The session was of special significance in view of the droughts of the last few years, and in like manner to the problem itself considerations did not stop at the international border line. Eleven papers were presented, some in abstract, for discussion covering every major aspect of the question. Precipitation was dealt with by the Director of the Meteorological Service of Canada; runoff by the director of the Dominion Water Power and Hydrometric Bureau. Three papers on geological aspects of the Prairies were read by members of the staff of the Dominion Geological Survey, Ottawa. Water phases of the drought relief program of the U. S. Federal Emergency Relief Administration were described by L. A. Jones, of Washington, and the contentious problem of tree planting in relation to drought control was reviewed by Norman M. Ross, chief of tree planting at the Forest Nursery Station, Indian Head, Sask. Four papers on water-conservation measures completed the program, two by engineers of the staffs of the C.N.R. and C.P.R. in the Prairies, Messrs. Main and Perry; one on rural water supply in Alberta was given by W. Calder, of the Department of Lands of the Alberta government; and finally a suggested storage scheme on the South Saskatchewan River was offered by W. Blue, of the Gatineau Power Co., Ottawa.

The character of the discussion was not in keeping with the mass of interesting and valuable information presented in the papers, but it was emphatic in recognizing the vastness of the problem, its pressing nature, and the fact that it could not be considered from any one angle to the exclusion of all others. The relation of climate to conservation measures, and in particular to tree planting (and vice versa), inevitably brought forth many diverse views. Generally, the suggestion con-

tained in Mr. Main's paper that the subject was one that could only be satisfactorily dealt with by a small commission of technical men, coordinating the work now being done by government departments, universities and private individuals, was endorsed. Nothing definite resulted from the discussion, but it was indicated that in view of the urgency of the problem, its national character and the information collected in the papers presented, a committee of the Council of the Institute would probably continue the work started in such an auspicious way at this meeting.

The attention to this matter was in strange contrast to the announcement of the Dominion Government's policy with regard to the Prairie droughts, announced by the Minister of Agriculture in the House of Commons at Ottawa two days before the Institute's meeting. The Dominion Government is preparing to launch a program this coming spring, to deal with the matter, cutting across provincial boundaries in considering the matter nationally. The proposed work will be administered by the Department of Agriculture, aided by an advisory committee of "successful ranchers, wheat farmers, and business men," the minister announced. The basis of this federal plan appears to be the selection and development of demonstration areas operated as townships, of 36 square miles, tree planting in small blocks to provide shelter, etc., being subsidized and aided by the government. The plan, as announced, appears to deal with the whole matter purely from an agricultural point of view, the neglect of engineering and engineers being significant.

On this subject, Mr. Ross, in his paper, stated that suggestions to counteract the effect of the drought have been freely offered by those not sufficiently conversant with the practical problems involved, advocating schemes of a wholesale nature, the execution of which would involve enormous expenditure. Most of these suggestions have included wholesale planting of trees, with the claim that by so doing rainfall would be increased and the climate changed. Unfortunately, such claims are not justified by available data and immediately invite adverse criticism. This, Mr. Ross said, is most unfortunate, for in the resulting controversy the great economic benefits which might follow systematic establishment of practical shelter belts are sidetracked and more or less overlooked.

Letters to the Editor

Continuous-Beam Design By Direct Distribution

Sir—I was very much interested in reading the article in your issue of Dec. 20, 1934, p. 782, entitled "Continuous-Beam Analysis by Direct Distribution," by John C. Schulze and William A. Rose. I was particularly interested in reading the statement at the end of the article, as follows: "The writers, in presenting this new conception of end restraint and the subsequent development of the method of direct distribution of the fixed-end moments by the use of the most elementary equations, hope that they have made a real and substantial contribution to engineering practice."

I have gone over this method, carefully checking it against the method presented in our "Standards of Design for Concrete" (U. S. Navy Department, Bureau of Yards and Docks), and find that, with some minor variations of little importance, the method is exactly the same as our own. In that book there is in a preface a statement relative to this method, and in appendix D there is given a complete derivation of the method applicable to continuous beams and continuous frames with variable spans, section moduli and loadings.

This method was developed by Harris Epstein, designing engineer on the bureau's staff, some fifteen years ago, but was never written up for publication until it was presented in our "Standards of Design for Concrete," which was issued on Nov. 15, 1929. As some 8,000 copies of this publication have been distributed, the method must be quite widely known at the present time.

BEN MOREELL,
Lieut. Comdr. (CEC) U.S.N.

Washington, D. C.,
Dec. 28, 1934.

* * *

Sir—I have read with much interest the article by Messrs. Schulze and Rose in your issue of Dec. 20, 1934, p. 782, relating to the analysis of the continuous girder. The method used is in general quite similar to that described in the fourth (1932) edition of "Principles of Reinforced Concrete Construction," by Turneaure and Maurer. But in some respects it seems to be somewhat more involved in its derivation and application. In the book referred to (Art. 239), coefficients a and b are calculated that correspond to coefficients f and f' of the article. The formulas for these are readily derived by applying the three-moment theorem to any two consecutive unloaded spans of a continuous girder. Paying strict attention to sign, they are

$$a_n = -\frac{K_{n-1}/K_n}{2(l + K_{n-1}/K_n) + a_{n-1}} \qquad (1)$$

and

$$b_n = -\frac{K_n/K_{n-1}}{2(l + K_n/K_{n-1}) + b_{n+1}} \qquad (2)$$

in which K is I/l, the stiffness coefficient for any beam and n is the number of span or support from the left end. Using the notation of the article, the corresponding formula for f would be

$$f_n = \frac{l}{2(l + r_{n+1}) + f_{n-1}r_{n+1}}$$

These coefficients a and b (or f and f') enable the moments at all supports to the left or right of any loaded span to be calculated as soon as the moments at the ends of the loaded span are found. It is in the calculation of these moments that the two methods differ most widely.

In the book (Art. 278), a method of distribution is explained whereby a moment applied at any support can be distributed to the adjoining spans correctly and finally by a single operation. This is done by calculating a modified value of K for each of the two adjacent spans that will represent the stiffness coefficient for the entire beam to the left or right of the support in question. Then the applied moment is distributed to the adjacent spans in proportion to these modified values of K. Formulas for these modified values of K are derived by applying the slope-deflection equation to the two spans on either side of the support, using coefficients a and b as already defined. These formulas are, letting K' represent the modified value of K;

For span n and structure to the left,

$$K_n' = \frac{K_n}{l + \frac{a_n}{2}} \qquad (3)$$

For span n and structure to the right,

$$K_n' = \frac{K_n}{l + \frac{b_n}{2}} \qquad (4)$$

With values of K' determined, the unbalanced moment at any support is distributed once for all to adjoining spans and, then by means of the coefficients a and b, the moments at all other supports are calculated. For a complete analysis the moments are determined for each span loaded in turn, and any desired combination is obtained by summation. An illustrated example is given in Art. 279.

Where the problem of continuous-girder calculation frequently arises, it appears to the writer that the foregoing method has some merit over the ordinary method of moment distribution.

F. E. TURNEAURE,
Dean, College of Mechanics and Engineering, University of Wisconsin.

Madison, Wis.,
Jan. 3, 1935.

ENGINEERING NEWS-RECORD

Volume 114, No. 8

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EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, N. A. Bowers, W. G. Bowman, W. W. DeBerard, F. W. Herring, C. S. Hill, H. W. Richardson, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d Street, New York

February 21, 1935

Housing as Relief Work

FIRST actual construction on one of the federal-financed-and-owned housing projects began in Atlanta last week when the first shovelful of dirt on the Techwood development was turned. Land-purchase activities are under way in about a dozen cities, and demolition has been started in one, but the Atlanta work is the first actual construction. The history of the Atlanta project is interesting in view of the proposal to allocate a large block of the new work-relief money to federal housing. Originally developed in the fall of 1933, as a PWA limited-dividend project, it was transferred to the Public Works Emergency Housing Corp. in March, 1934. First land-condemnation proceedings were started April 15, 1934, and demolition of the old buildings began on Sept. 29. Bids were asked on the new buildings Nov. 26, 1934, contract was let about Jan. 1, 1935, and actual work has just now begun. Between the time that land acquisition was commenced and construction labor received jobs, ten months elapsed. If the Atlanta project is indicative of what may be accomplished through a federal housing program, only a small amount of employment could possibly be created in 1935 if the work-relief bill were passed tomorrow. Yet the big fact remains that the country's housing equipment is so antiquated as to make aggressive attack on its modernization a real national need. Despite its slowness, the PWA's housing campaign deserves high recognition as the beginning of this attack.

Speed with Safety

WEEK AFTER WEEK reports are received of new tunneling records established on the Colorado River Aqueduct. Old driving records have been relentlessly smashed from one end to the other of that great project, topped by the recent great feat of driving 1,111 ft. of hard-rock heading from one face at Copper Basin No. 2 in 30 days. These reports suggest feverish activity—a pell-mell rush that would leave the inevitable trail of accidents in its wake. Such is not the case. Incredible as it may seem, while the aqueduct has been made the speediest tunneling project in history, it has also been made the safest. Safety here is more than a slogan—it is an actual reality. The entire organization from commission heads to drill runner and chuck tender—engineering, contracting and force-account crews—has been permeated with the safety idea. Safety is taught and then practiced. Eternal vigilance, attention to every detail and consideration of every suggestion made by the workers are answers to the question of how the accident rate has been cut to less than half of the normal for the state in tunnel work. Over a 241-mile stretch of California desert these tunnel forces are proving that construction hazards can be overcome and that high construction speeds can be obtained without sacrifice of human life and limb. They are giving a convincing demonstration of the place that the tunneling art has reached through the aid of modern machinery and tools and thoroughly studied procedures.

Essential Improvement

WHEN the new federal construction bill went to the floor of the Senate last week, it carried with it a number of amendments that remove some of its vagueness and begin to give tangible form to the program of operations which it will initiate. Among them is one of especially vital character. By providing that "wherever practicable full advantage shall be taken of the facilities of private enterprise," it makes a major step in transforming a relief measure into an agency of recovery. The brief but effective requirement, if fully applied, will extend the reviving influence of the bill over a broad zone of industrial and business life. Such influence was alarmingly absent from the relief and construction measures of the past two years, as engineers and contractors know by sad experience. The first essential of recovery activity—to avoid further breakdown of the going system—was ignored, and until the Senate committee inserted the present amendment there was every probability that this would be true also of the new program, as the Administration was known to lean strongly toward force-account operation. The amendment now written into the bill offers the first assurance against the hazard that the huge expenditures will be thus sterilized.

To Continue Road Construction

IN ADDITION to the private-enterprise amendment, the Senate committee made other important changes. It removed the authorization to reorganize governmental agencies, added the requirement that roads, rivers and harbors, reclamation and public buildings be carried out by the federal agencies now charged with jurisdiction over such works, limited the scope of the bill to projects of types that are or may be authorized by law, and empowered the President to fix wage rates below the prevailing level, in accordance with the sound principle laid down in his opening message to Congress. These revisions further strengthen the constructive effect of the measure. Another significant change is embodied in an amendment just introduced by Senator Hayden, which allocates to road construction the amount authorized in the Hayden-Cartwright Act of last June. The justice of this amendment can hardly be questioned, for no class of work has made so great a contribution to re-employment and relief of the distress attendant on idleness as road construction. The amendment merits warm support. It offers effective guarantee that through road and grade-crossing improvement the bill will begin producing a substantial volume of employment promptly after becoming effective.

Sludge Elutriation

DISPOSAL of digested sludge at sewage-treatment plants by aid of vacuum filtration has gone far to solve this troublesome and expensive problem in sanitation. For proper functioning of the process, however, it is necessary to coagulate the fluid material by chemical means, and a large share of the cost of dewatering is accounted for by the cost of the coagulant employed. A few years ago research into this problem at Baltimore disclosed that a goodly proportion of the coagulant was used up

in combining chemically with dissolved constituents of the sludge, and was accordingly unavailable for its intended purpose of clotting the sludge solids. The elutriation process that grew out of this discovery consists essentially in reducing the concentration of these dissolved coagulant-absorbing constituents by dilution and decanting before the chemical is added, and has a marked effect in reducing correspondingly the amount of coagulant necessary. On another page of this issue there are reported the results of recent tests designed to disclose the extent to which this elutriation should be carried to obtain the greatest degree of economy. The tests show that under the conditions at Baltimore an elutriation with seven or eight volumes of water will reduce the cost of dewatering to an unprecedentedly low figure. Thus, research again demonstrates its value in furthering the efficiency and economy of a technical process.

A Real Safety Factor

CALIFORNIA'S RECORD of active enforcement of its registration law for civil engineers is one of which any state may well be proud. No law is of value unless it is rigidly enforced; in fact a law that is not properly enforced is definitely harmful. A license law that is not brought forcefully to the attention of would-be violators loses the respect of the profession and yet gives to the public a false sense of security so long as it remains on the statute books. Nevertheless the engineering profession in general has been reluctant in the matter of enforcement, partly because of unwillingness to press charges of unethical or illegal conduct, but partly also because of fear that strict enforcement might subject the law to strong, and possibly effective, attack. The California board has not been deterred by such fear. Violation after violation has been sought out and prosecuted, with the result that a large number of convictions have been obtained, and many cases now are on the records of the state as precedents that will simplify future action. A law thus strongly entrenched becomes the real asset to the state that all license laws in theory are supposed to be.

A New Roadbuilding Tool

GEOPHYSICAL EXPLORATION is presented in this issue as a practical scientific aid to the roadbuilder. Favorably known in the mining field as a method of prospecting underground mineral deposits, it has within the last year proved its possibilities as a means of locating subsurface gravel beds for road construction. Its actual use has been limited, but the process has advanced much farther in the speculations of materials' laboratory workers, a number of whom, including those of the Bureau of Public Roads, have developed working plans. In addition to an instrument of the electrical-resistivity type, the federal laboratory has devised a seismograph designed particularly for shallow prospecting. The two instruments, it is believed, will make possible the reconnaissance not only of subsurface deposits of road metal but of foundation materials, and perhaps will be useful in classifying excavation for the bidding sheet. Meanwhile the successful use of the electrical-resistivity method by the Minnesota highway department as outlined in this issue advances geophysical exploration well into the field of actual use. As developed, it proves to require trained skill, but to be quite within the ability of any highway department to organize and equip.

Bridge-Building Boom

BRIDGE BUILDING is a field of activity that may soon experience a boom of nationwide scope. Added emphasis is laid on this possibility by the attention given to improvement of inadequate highway bridges and to grade-crossing elimination structures in the canvass of projects for the new federal construction program. But the case hardly needs such emphasis, for those familiar with bridge requirements have long foreseen a strong revival of activity in this field.

Various well-known facts give point to this conclusion. There is a recognized deficiency in the small-bridge field. Great structures, such as those at San Francisco, are built only at intervals measured in decades, while the more modest though relatively large bridges over wide streams require too much individual promotion for them to be considered as a potential source of much bridge construction in times like these. But the small or medium-size bridge is in quite another class. Even in good times such bridges have never been equal to the need. During the past few years, with roadbuilding continuing close to normal (thanks to federal emergency funds), new bridge construction has not kept pace.

For one thing, it was believed, probably erroneously, that there were larger employment possibilities in straight roadbuilding. For another, plans were not ready for bridges, except in a few instances, and speed was the essence of emergency spending. Again, there was the need to spread the work and the funds widely, and bridge construction was held to concentrate them. Under the circumstances it was concluded that existing bridges would have to continue to serve. That they serve inadequately, inefficiently and sometimes dangerously will soon become apparent if it has not already done so. Catching up with the emergency roadbuilding program, then, offers one point in support of a bridge-building boom.

In another field the situation is analogous but of even greater potentiality. Grade separation at the crossing of trunk highways has captured the public imagination wherever it has been tried. Where bridges were formerly thought of only as crossings of stream courses, they are now accepted as crossings of other highways. Catching up with the need for grade separations may require more bridges even than will replacing obsolete stream bridges.

And finally there are the railroad crossings of highways at grade. Their number runs into thousands. Slowly but surely the public is coming to the conclusion that these crossings must be eliminated wholesale, and without waiting for the railroads to pay part of the cost. Acceptance of such a program is long overdue, for it is apparent that railroads are in no condition to make the expenditures required if they are to continue to bear a large part of the cost. Further, it has always been obvious that the public would pay for the crossings in the end through increased rates.

All of these potentialities—replacing of obsolete stream bridges, construction of highway separation structures and elimination of railroad crossings at grade—have of course existed for years. More and more, however, the need for this bridge construction is being acknowledged. It seems certain that it soon will be reflected in a large volume of bridge reconstruction and replacement. A bridge-building boom, in short, is not beyond the realm of possibility.

CURRENT NEWS

Work-Relief Bill Goes to Senate And Debate Begins

(Washington Correspondence)

THE $4,880,000,000 works-relief bill has been reported to the Senate by the Appropriations Committee with the customary recommendation, by Chairman Glass, "that it do pass." Senatorial debate on the measure began Friday, Feb. 15. After Senator Glass had explained, in caustic vein, the purposes of the committee amendments, Senator Vandenburg made an attack on the bill. On the day previous, Senator Steiwer voiced his opposition to the measure, stating that the proviso that the work be of a type authorized by law means little because the government has done almost everything at one time or another.

Senate Republicans are demanding that the administration of the fund be limited to one year instead of two. Republican sentiment is toward the McCarran prevailing wage amendment and sentiment is divided as to reducing the fund by $2,000,000,000. Bonus advocates are moving to pay the $2,200,000,000 cash bonus out of the $4,880,000,000 fund.

Advisory committee

Robert E. Wood, president of Sears, Roebuck & Company, has been appointed chairman of a business committee to advise the Administration on the carrying out of the works program. The committee will serve on a volunteer basis and is an offshoot of the Business Advisory and Planning Council of the Department of Commerce. Three committees of the council which have been working along these lines are: private construction, A. P. Greensfelder, chairman; decentralization of industry, W. A. Julian chairman; and financing private construction, R. G. Elbert, chairman. Members of the new group have not been selected. Functions are said to include examination of projects with suggestions as to their advisability.

Returns from PWA's nation-wide survey of possible works projects will be in by March 1. This will indicate jobs in addition to projects now in the PWA portfolio, totaling $1,000,000,000 of federal work which Secretary Ickes says can be undertaken quickly and $1,000,000,000 of non-federal jobs of which $600,000,000 can commence on short notice.

Vancouver, B. C., Has $2,000,000 In Possible Building Work

A tabulation totaling almost $2,000,000 in useful and necessary public improvement and buildings for Vancouver, B. C., and vicinity has been compiled by public and semi-public agencies as a preliminary to a large unemployment relief program. The tabulation was left in the hands of the civic board of works to be put into shape for presentation to the government.

San Jacinto Tunnel Operations Taken Over by District

The Metropolitan Water District of Southern California on Feb. 12 took over work on the San Jacinto tunnel unit of the Colorado River aqueduct project which had been suspended since Feb. 9 by the Wenzel and Henock Construction Co., contractors, pending the settlement of litigation instituted by the district to enforce its order suspending the company's contract. After first asking dismissal of the proceedings instituted in the federal court, the district sent three crews of thirty men each to take over work at three construction centers on the tunnel project, at the west portal near San Jacinto; at the Potrero shaft eleven miles southwest of Banning, and at the Cabazon shaft. The occupation of the centers by the district forces was made without opposition by the contractor crews.

On Feb. 7 was denied a temporary injunction sought in the United States District Court to prevent interference with the tunnel work. The district's action was directed against the Wenzel and Henoch Co. The district court at the same time denied the motion of the company asking dismissal of the water district's bill of complaint, and gave the company twenty days in which to file an answer. On Jan. 15 the water district had notified the construction company that its contract for the construction of the San Jacinto tunnel had been suspended because of unnecessary delay in furthering the work. The company formally refused to surrender work on the tunnel and the district made application for a court order restraining the contractors from continuing with the work and from interfering with the district taking it over.

Four fatalities resulted from a fire Feb. 12 in a bunkhouse and commissary at Cabazon, near Banning, Calif., housing Colorado River aqueduct laborers.

First Construction Work Starts on All-Federal Housing Project

Construction work began on the first all-federal project in the $150,000,000 PWA slum clearance and low-rent housing program with the ground-breaking ceremonies for the Techwood development in Atlanta, Ga., last week. The construction contract is held by the J. A. Jones Construction Co., Charlotte, N. C., for $2,108,337. The work is scheduled for completion within a year and is to provide 3,000,000 man-hours of employment.

The Techwood development will be of fireproof construction providing 603 family units in apartments and row-houses and 159 dormitory rooms for students at the Georgia Institute of Technology which adjoins the site. The work will include construction of seven courts of row-houses, thirteen three-story apartment buildings, the dormitory, a playground shelter, and an administration building with offices, stores and equipment for a clinic. There will be 397 living units of three rooms, 128 of four, 53 of five, and 26 of six rooms.

Senate Requests Information On Federal Building Contract

(Washington Correspondence)

Secretary Ickes has been instructed by the Senate to turn over all reports and information as to contracts let to the James Stewart Co., which hold the contract for the post office annex building in New York, with particular reference to supplies furnished by the General Builders' Supply Corp.; also to transmit anything that Louis Glavis, investigator of the Department of the Interior, or others may have regarding Postmaster General Farley. According to Senator Long, at whose instance the resolution was passed, Postmaster General Farley is heavily interested in the General Builders' Supply Corp. which, Long believes, has been favored by business on federal project work in New York. Secretary Ickes stated that no doubt Mr. Glavis has investigated the two companies as a matter of routine and that the reports will be submitted.

Second PWA Housing Project Started in Montgomery, Ala.

A second low-rent housing project for the city of Montgomery, Ala., has been announced by the PWA with the filing of a declaration to acquire title to about 14 acres for the development. The PWA has allotted $244,000 for the work, which will provide single-story row houses for 100 living units. This second Montgomery project is the twenty-first to be announced by the PWA in its $150,000,000 slum clearance and low-cost housing program. Work is under way in more than 30 cities on the program and three limited-dividend corporation projects have been already completed. Slums have been cleared for five of the federal projects, including the first Montgomery development, and the construction contract has been awarded for the first federal project to reach actual construction.

Ohio Engineering Society Joins National Group

At the fifty-sixth annual meeting of the Ohio Engineering Society at Columbus Feb. 14, a unanimous vote was cast to join the National Society of Professional Engineers. The action taken by the Ohio society brings the number of state societies affiliated with the national body to eight with West Virginia tentatively approved. The meeting also voted unanimously to change the name of the organization to the Ohio Society of Professional Engineers, and to restrict full membership to registered professional engineers.

The present membership of the Ohio Society is about 800, and the convention attendance, according to report, was 600. A beginning has already been made to start county chapters of professional engineers in practically all of the counties in the state of Ohio.

IN WASHINGTON

By Paul Wooton

Washington Correspondent

PROSPECTS favor the passage of Senator Hayden's amendment to the work relief bill. It provides that the $125,000,000 for federal aid roads for the next fiscal year must come out of the lump sum and appropriates the $100,000,000 balance of the $200,000,000 previously authorized. These funds would be allocated and expended as provided in the highway act. Such expenditures as may be decided upon for grade crossing elimination are to be allocated to the states on the following basis: Population 50%; railroad mileage 25%; federal aid highway mileage 25%.

There is little doubt that the President's proposals with respect to the extension of NRA will be approved by Congress without substantial modification. There will be extended debate but in the end NRA will be continued. Given this additional lease on life the prevailing opinion is that codes of fair competition will become so well entrenched as to form a permanent part of the business structure. They will be greatly simplified and fundamental changes made. Provisions aimed at sales below cost probably will be dropped. In some codes no effort will be made to set up fair trade practices. In construction the trend will be toward more rigid requirements in connection with the filing of bids.

Every effort will be made by those immediately concerned with the recovery of durable goods to keep out of the work relief legislation any requirement for the maximum use of hand labor. Wasteful use of hand labor, it is contended, means that the taxpayer gets less in the way of permanent improvement and means lessened stimulation for the heavy industries.

West Hartford to Join District In Sewage Disposal Plan

West Hartford, Conn., has taken steps to enter an agreement with the metropolitan sewerage district around Hartford for disposal of sewage through trunk lines of the district. Ultimately treatment will be provided at a central plant and West Hartford will pay its share of $650,000 of the cost. All but two of the sewer systems in West Hartford are included in the agreement. At the present time the city is completing the Center trunk sewer, which will serve 75 per cent of the town and will be connected with a 4,000-ft. interceptor line to the new South interceptor, being built by the district.

Registered Engineers' Bulletin Published in California

The first issue of "The Registered Civil Engineer," a quarterly news bulletin issued by the California State Board of Registration for Civil Engineers, recently made its appearance. The bulletin will print "news relative to the administration of engineers' and surveyors' laws, interpretation of the Board's rules, opinions of the attorney-general regarding the laws, reports of investigations, formal complaints filed, hearings and prosecutions."

Grand Coulee Dam Employment Reaches New High of 2,692

Employment on the Grand Coulee Dam project early in February reached a new high total of 2,692, exclusive of the engineering force of the Bureau of Reclamation totalling about 150. The bulk of this employment is provided by the main contract work held by the Mason-Walsh-Atkinson-Kier, which increased its employment by 70 men to 2,398 on Feb. 8. The remainder of the employment is divided between numerous smaller contractors.

The conveyor belt system which is being used to remove excavated material from the dam site is operating at an average rate of nearly 30,000 yd. in a 21-hour day. A third feeder unit has been added to the system but has not increased the output of the conveyor materially because the initial digging area is small and only two or three trucks are able to operate between the 4-yd. electric shovel and the loading end of this feeder belt. The total yardage removed by the main contractor to date is nearly 1,000,000 yards.

Study of New England Rivers Planned by Commission

Important steps were taken by the New England Regional Planning Commission at Boston on Feb. 13 to investigate pollution, flood control and other problems in connection with the Connecticut, Merrimack and Blackstone river valleys. An advisory committee was partially named to report on these matters, including H. K. Barrows, consulting engineer; Arthur D. Weston, chief engineer Massachusetts Department of Public Health; and Sanford H. Wadhams, chairman of the Connecticut Water Commission. Three representatives from Vermont, New Hampshire and Rhode Island will be named later by the chairman, Victor M. Cutter of Boston.

The need of preventing pollution of the Merrimack River from New Hampshire to the sea and of the Connecticut River above the Massachusetts line were stressed at the conference. John H. Cady, consultant for the Rhode Island Planning Commission, outlined the proposed Blackstone valley sewerage disposal project to serve Pawtucket, Central Falls, Lincoln, Cumberland and East Providence. This involves a central disposal plant at Bishop's Bend, to cost about $500,000, and another half million dollars for a connecting sewerage system. Consultants assigned to the various state planning boards, besides Mr. Cady, are Arthur C. Comey and Alfred Mulligan of Maine; John Noelin and Justin R. Hartzog, of New Hampshire; and Dr. C. H. Chakerian of Connecticut and Philip Shutler of Vermont. Joseph T. Woodruff and Frederick P. Clark are consultants to the regional commission.

January Building Permits Increase Over 1934

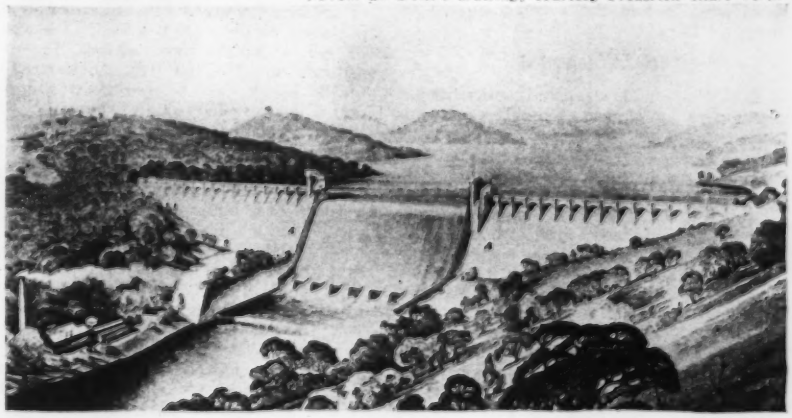
Reports from many municipalities indicate a material increase in building permits and building construction for the month of January as compared with the first month of 1934. A substantial increase in building construction in the borough of Manhattan, New York City, has been announced with the report showing the filing of plans for seventeen new buildings to cost $910,000 in January, 1935, as compared to filings for four buildings to cost $607,000 in the first month of 1934. Further, filings for alterations totalled 263 during the past month, corresponding to 215 filings for alterations in January, 1934.

Building permits in Los Angeles, Calif., for January, 1935, totalled 1,528 with a valuation of $2,188,000 as compared to permits totalling 1,489 in January, 1934, with a total valuation of $980,330. Building operations in Birmingham, Ala., during January, 1935, totalled $142,720 compared to $111,275 for the similar month last year.

TYGART RIVER DAM AS IT WILL LOOK WHEN COMPLETED

Work was started last month on the Tygart River Reservoir Dam in West Virginia by the Frederick Snare Corp., New York, contractor on the project. Contract was let by the U. S. District Engineer Office, Pittsburgh, for $6,249,000. This is the first of a series of detention reservoirs planned for the upper Allegheny and Monongahela River basins for flood control in the Pittsburgh area. A description of the Tygart Valley project was published in *ENR* July 12, 1934, p. 48. The contractor has announced the intention of using a high steel trestle for concrete placement on the 1,800-ft. dam.

From an artist's drawing; courtesy Frederick Snare Corp.



Effect of New Deal Policies on Engineers Discussed at New York Meeting

POLICIES and practices of the present administration as they affect engineers were actively attacked and defended at a meeting of several hundred members of the Metropolitan Section of the American Society of Civil Engineers held in New York on Feb. 18. Principal speakers were Henry M. Waite, former Deputy Administrator of Public Works, D. B. Steinman, president of the National Society of Professional Engineers, and J. P. H. Perry deputy director of the works division of the Emergency Relief Administration in New York City.

Effect on consulting engineers

Dr. Steinman, speaking from the viewpoint of the practicing consulting engineer, criticised the PWA for its failure to provide for the payment of fees for consulting services in the preparation of PWA projects in advance of approval and laid on the PWA doorstep responsibility for much of the present demoralization of consulting practice. He also criticized the profession for extensive cut-throat competition and its failure to live up to its ethical standards. Dr. Steinman pointed to the possibility of further demoralization of the profession under the pending work-relief legislation and called upon the profession to resist regimentation and nationalization.

Work relief

J. P. H. Perry outlined the position of engineers in work-relief operations, citing the many limitations to efficient operation that exist in any organization that is directed largely by social workers whose only conception of "work" is hand work. Until we know whether the emphasis is on *work* or on *relief* in work-relief, said Mr. Perry, there is bound to be confusion. Though studies made by the works division show that the direct cost of work relief is considerably higher per family than is direct relief Mr. Perry stated emphatically that the community is well paid in permanent improvements for the added cost, to say nothing of the moral effect.

Mr. Perry reviewed the works division's efforts to get better pay and classifications for engineers but pointed out that the division's officers are handicapped by many limitations. He stated that despite the adverse conditions under which his staff worked its morale was high and its interest in the work was notable, men frequently working late into the evening though no overtime is paid.

PWA defended

Col. Waite took strong exception to Dr. Steinman's indictment of the PWA as the chief source of the consulting engineers' troubles and stated that they had themselves to blame for much of the cut-throat competition and unethical practice. In support of this he said that in the two years during which he sat on the board of direction of the Am. Soc. C.E. every case of unethical conduct that came up for consideration was concerned with the conduct of consulting engineers.

Col. Waite said that the chief trouble with engineers is that they are not socially minded, that they insist upon dealing only with facts, figures and inanimate things, not with people. He cited the report of the Mississippi Valley Committee as an outstanding example of socially-minded thinking on the part of engineers.

Engineers on relief

Discussion of the subject from the floor was active. W. A. O'Leary, speaking for the engineers employed on city work and on relief, pointed out the demoralizing effect of turning regular city work over to relief work thus throwing men out of regular civil service jobs and forcing them to go on relief with its lower pay and many inequalities in classification.

At the close of the meeting a resolution was adopted urging upon Congress the need for retention of Section 7 in the joint resolution appropriating four billion dollars for work relief. This section states that "wherever practicable in carrying out the provisions of this joint resolution, full advantage shall be taken of the facilities of private enterprise."

New York Law Will Restrict Improvement Districts

The New York state law which prohibits the establishment of new improvement districts except on approval of the state comptroller with no such approval to be given where the district is to be erected in any town with a debt exceeding 10 per cent of assessed valuation of real estate, has been extended for another two years until May 2, 1937, by an act signed by Governor Lehman Feb. 16.

The governor also approved an act authorizing the creation of a state debt and making appropriation providing for the continuation of construction on a Grand Central Parkway extension to Flushing Bay, an extention of the Interborough Parkway to Grand Central Parkway and Highland Boulevard, and an extension of the Southern State Parkway to Sunrise Highway.

PWA and RFC Improve Plan For Private Sale of Works Bonds

To facilitate the already successful policy of selling bonds held by the PWA to private investors, an arrangement has been made with the Reconstruction Finance Corporation which is designed to give many of the smaller dealers in securities an opportunity to bid. Of the $4,938,450 worth of bonds which were offered for sale through the RFC on Feb. 20, thirteen of the 33 issues were offered under the new option plan which enabled the successful bidder to take at least one-third of the issue offered with the privilege of buying the remainder within fifteen days.

The new option plan is expected to bring a wider distribution of the bonds held by the PWA, the sales of which have already netted the federal government a cash profit of nearly $1,000,000. PWA has sold prior to the Feb. 20 offering, securities totaling $53,893,685, with a profit of $903,767, or 1.67 per cent on the operations. It is the PWA policy to return the public works financing operation to the private investment market as fast as that market is able to reassume this burden.

Contract Let for Remainder of Triborough Bridge Foundations

The Frederick Snare Corp., New York, on a low bid of $803,989 has been awarded the contract for the construction of piers on Randall's Island and at the Little Hell Gate and Harlem River crossings of the Triborough Bridge project. Six of the seven bids submitted were below the engineer's estimate of $991,000. The construction work includes 26 concrete piers extending from Ward's Island to the junction point on Randall's Island and eleven more on the Manhattan arm. Over the Harlem River these piers will support a vertical lift span. The Triborough Bridge Authority released figures indicating that the project was providing direct employment for 777 persons including an office staff of 177. Bids will be opened March 14 for steel work on the suspended span and the approach viaduct from Queens to the junction of the Manhattan and Bronx approaches on Randall's Island. This superstructure work is estimated to cost more than $3,000,000.

Transmountain Diversion Plan To be Studied with PWA Funds

An allotment of $150,000 has been made by the PWA for an investigation and report on the proposed transmountain diversion project to convey water from the Colorado River basin to the South Platte River basin in Colorado. The allotment was made to the Bureau of Reclamation.

The plan contemplates diversion of Colorado River water, to which Colorado is entitled, from the western slope of the Continental Divide to the eastern slope where there is a shortage for irrigated areas and towns in the South Platte Valley. The investigation will include: (1) engineering and geological surveys to determine the most feasible location together with preparation of plans and estimates, (2) determination of the amounts of water that can be diverted, (3) determination of the areas to which the diverted waters would be furnished and the benefits, (4) determination of present and probable development on the western slope which would be affected by the proposed diversion, and (5) study of reservoir sites on the western slope which would be suitable for development to impound waters to replace those to be diverted.

Combined State and County Roads Proposed in California

"Abandonment of the existing dual system of state and county roads and the inclusion of all highways into a single state system whereby greater economy in construction and maintenance may be assured," was one of the recommendations which Frank F. Merriam, governor of California, made to the State Legislature in his budget message presented Jan. 22. Under this plan, the governor said, "counties will be relieved of the necessity for levying property taxes for road purposes and through the elimination of 58 separate county road departments millions of dollars annually will be saved * * * There is no economic justification of this vast duplicating system operated by the counties."

North Atlantic Highway Meeting In Baltimore

TOPICS ranging from specific problems of road design and construction to broad questions of transportation economics and employment policies were covered in the program of the Association of Highway Officials of the North Atlantic States at its annual convention last week at Baltimore, Md. About 500 registered attendance including representatives from some half a hundred manufacturers who displayed samples, models and pictures of road materials and equipment. Including two groups of short reports (a report from each of the eleven state members of the association) on work available for immediate and early construction and on construction methods for low-cost roads, the program listed 13 major papers.

The subjects covered were: Brick Pavement Construction—Chestnut and Walnut Streets, Philadelphia, by Paul Tebbs, Assistant Chief Engineer, Pennsylvania State Highway Department; Highway Lighting, by Arthur J. Sweet, Consulting Engineer, Westinghouse Lamp Company; Motor Truck Development and Future Possibilities, by Merrill C. Horine, International Motor Truck Corporation; Effect of Federal and State Restrictions on Highway Contract Work, by Wm. P. McDonald, President, Wm. P. McDonald Construction Co.; Developments in Transverse Expansion Joints and Fillers in Concrete Pavements and Bases, by R. E. Toms, Chief, Division of Design, U. S. Bureau of Public Roads; Ability of State Highway Departments to Place Men at Work on Highways and Grade Crossing Eliminations, by state representatives; The Vitality of the Highway Industries Under Depression Conditions, by Roy F. Britton, Director, National Highway Users Conference; Construction and Maintenance of Low-Cost Roads, by state representatives; Developments in Cold-Laid Bituminous Pavements, by A. T. Goldbeck, Director, Bureau of Engineering, National Crushed Stone Association; Soil Stabilization by C. A. Hogentogler, Bureau of Public Roads; Agency and Method for the Maintenance of County Roads, by H. G. Shirley, Commissioner of Highways, Virginia, and Rational Highway Planning, by E. M. Fleming, Manager, Highways and Municipal Bureau, Portland Cement Association.

Abstracts of several of these papers will be given in an early issue. The discussion in general was limited except on joint design and soil stabilization.

Texas Cities List Projects For New Works Program

Municipal authorities in Texas, following the request for a list of projects which could be carried out by the new works relief program, have prepared a comprehensive list of public works projects which could be undertaken. The city of San Antonio has submitted an inventory of proposed improvements totalling almost $14,000,000, Houston has listed work aggregating $15,000,000 and Fort Worth $7,650,000.

Changes in New Orleans Market Will Permit Levee Set Back

Bids will be opened on March 7 by the French Market Corporation for the construction of new buildings and renovation of existing buildings comprising the famous Old French Market. The reconstruction of the market is a matter of interest from the fact that the project will make room for the setting back of the Mississippi River levee at that point. The river bank, at that location, is subject to scouring effect of the river as it passes around Algiers point and setting back of the levee is considered necessary by engineers. The moving of the levee also involves the tearing up of North Peters Street and the moving of the Louisville & Nashville, Southern Pacific and N. O. Public Belt Railroad tracks.

The project is financed in part by the French Market Corporation, a company formed by property owners and merchants in the district, the Orleans Levee Board, the City of New Orleans, and the Public Works Administration.

Violators of Licensing Act Prosecuted in California

In 24 months 23 violations of the California law governing the practice of civil engineering were prosecuted and 21 convictions obtained, according to the third biennial report of the California Board of Registration for Civil Engineers which appeared recently. The maximum penalty assessed was a fine of $100 or 50 days in the county jail. In a number of cases the fine and jail sentence were suspended dependent upon good behavior for a period of from one to two years; or the defendant was placed on a probation for a two-year period.

Code Authorities Lack Power to Impose Penalties

CODE AUTHORITIES and administrative agencies cannot impose penalties upon alleged violators beyond those stipulated by the Recovery Act, according to a recent NRA ruling and opinions by the Construction Code Authority Counsel. These rulings have important bearing on the present practice of forcing subcontractors to withdraw bids because of some violation, a practice which has caused consternation in the ranks of general contractors who often suffer financial losses when a low sub-bid is declared void after it has been used.

Robert N. Campbell, Acting Division Administrator, directs attention to the fact that penalties for violations of codes are set forth in the Recovery Act, and that it is clearly beyond the powers of a code authority to attempt to impose additional penalties. He states that a number of cases have been presented in which code authorities, or their agencies, have been causing bidders to withdraw bids for alleged violations of the respective codes; that the power of a code authority is limited to recommendation with respect to alleged violations and does not include the power to finally determine that a violation does exist, and therefore it is improper to cause the bidder to withdraw his bid although a violation may have been proven to the satisfaction of the code authority. Further, each code authority is responsible for the actions of any subordinate administrative agency. The ruling is in line with the opinion of the Attorney General some months ago to the effect that a code could not include a compulsory system of

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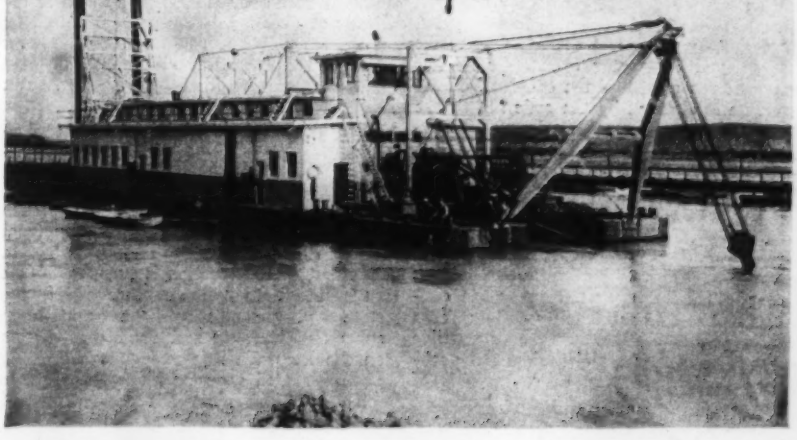
ONE OF FOUR HYDRAULIC DREDGES USED AT FORT PECK DAM

To place the 80,000,000 cu.yd. of hydraulic fill material which will be required to construct the Fort Peck Dam on the upper Mississippi River in eastern Montana, four large hydraulic dredges will be used. These timber dredges are 30x130 ft. in plan. Two 2,500 hp. electric motors operate two pumps on the dredge and two additional pumps operate in the discharge line on a floating booster plant, with one additional pump installed on a mobile land car. Each dredge unit, therefore, includes five pumps.

The dredge is capable of digging to a depth of 50 ft. below the water. The cutter head is driven at a speed of about 25 r.p.m. by a 700 hp. motor mounted on the end of the ladder. The total suspended weight at the digging end of the ladder is about 135 tons.

(Bucyrus-Erie Co. Photo.)



liquidated damages since the Recovery Administration was without power to impose penalties for violation of the codes beyond those prescribed in the Act.

General contractors object

The necessity for this ruling was brought out in numerous cases in which local code administrative agencies have caused members of the divisions to withdraw their bids for alleged non-compliance, such as not filing duplicate copies of the bid in designated bid depositories, or, as was more often the case, of quoting a price considered to be below cost. The practice has been strenuously objected to by general contractors who complained that they were being subjected to financial loss after having quoted a price based on sub-bids received. They have contended that the general contractor should not be penalized in this manner, or used as the medium for enforcing sub-contractor code chapters.

On the other hand, the sub-contractor groups have argued that if a sub-contractor is violating the code, and is allowed to proceed with the work, he may be entirely willing to gamble on being penalized under the code, and even if he is penalized, favorable breaks on the job might afford the basis of offsetting the penalty. At the same time, those who have complied with the code are discouraged by the fact that the violator is permitted to secure the job despite a disregard of industry regulations. Slowness in the operating of the compliance machinery and the many technical loopholes which appear, are cited as justification for the code authorities influencing the withdrawal of bids in outstanding cases.

Bidding below cost

The practice has concentrated chiefly about the withdrawal of bids for alleged bidding below cost. While mistakes in estimating occur occasionally in the quantities of material required, or the cost of such materials, more frequently the labor cost is the deciding factor which involves attempts to under-cut the minimum wage rates fixed by area agreements or by the code. Because of the difficulty of making a close check upon the rates paid on all jobs, even on those where under-cutting may be suspected, some groups have contended that it is necessary to examine carefully the pricing before the work is undertaken.

The construction code does not permit duplicate bids to be opened and tabulated until after the general contractor has used the sub-bids and submitted his price. Hence, the withdrawal of bids may strike the general contractor even after he has accepted the award of the contract. However, he is charged by the code not to use bids which are so unduly low as to indicate an error or mistake in estimating, without giving the bidder an opportunity to demonstrate the correctness of the bid.

In one related industry, the practice is followed of checking the bids submitted to a general contractor before the general contractor submits his price. However, this practice is not permitted by the construction code, and has generally been considered undesirable because of possible charges of collusion, and the difficult problem of keeping control over hundreds of administrative agencies throughout the country.

Funds to Be Requested for Sewerage Program at Seattle

Application for $3,500,000 of federal funds for a sanitation survey of King County (including Seattle) Washington, and construction of sewers to stop contamination of Lake Washington will be made at once by E. French Chase, chairman of the Lake Washington Metropolitan Sewers Commission, which was recreated Feb. 4 by the county commissioners. King County Engineer Joseph P. Dodd was named secretary and sanitary engineer for the commission. The Government will be asked for $140,000 to finance the sanitary survey and for $3,221,000 for the construction of intercepting and lateral sewers.

Court Denies Request To Inspect Engineers' Papers

Judge John C. Crosby of the Massachusetts Supreme Court has issued an opinion denying a petition of Durkee Mower, Inc., for a writ of mandamus to compel the city clerk, city engineer and superintendent of sewers at Lynn to allow the plaintiffs and their representatives to inspect all documents and records in the offices of these municipal employees. A suit on the ground of alleged damage to the plaintiff's property from flooding of sewers had been brought, and the plaintiffs sought particularly to examine plans showing the arrangement of a junction chamber at an intercepting sewer. Judge Crosby held that the Lynn city clerk had furnished the plaintiffs with all records except a paper which was not a public document, and that they had not shown the necessity for a blanket search of all documents in the hands of the respondents.

Save River Bridge Completed At Belgrade in the Balkans

A highway bridge in Europe of unusual importance was recently opened to connect Belgrade with Zemun over the Save River in the Balkans. The structure provides the first direct highway route between Belgrade and the territory to the north and the lack of this highway unit has been a severe handicap ever since the land beyond the Save River was united with Serbia in the Jugoslav Kingdom.

The bridge, which is similar in design to the self-anchored suspension bridge over the Rhine at Cologne, has been constructed by a French and a German concern working hand in hand with materials partly supplied as reparations in kind by Germany. But for the cessation of reparations deliveries, which delayed the completion of the work, the bridge would have been opened last year. Actually it has taken four and one-half years to construct.

The length of the bridge and approach viaducts is 1,967 ft. and of the span from bank to bank of the Save River is 804 ft. The cost of construction is over $4,250,000. In addition to the structure itself, the state and municipality have spent large sums on clearance and road construction on the Belgrade side and on the building of an elevated concrete highway over two miles of marshes between the bridge and Zemun.

SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, March 12-14.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Cincinnati, Ohio, May 6-10.

AMERICAN SOCIETY FOR TESTING MATERIALS, regional meeting, Philadelphia, Mar. 6; annual meeting, Detroit, June 24-28.

SOUTHWEST ROAD SHOW AND SCHOOL, eighth annual meeting, Wichita, Kan., March 5-8.

INDIANA SECTION, American Water Works Association, Indianapolis, March 7-8.

GREATER NEW YORK SAFETY CONFERENCE, sixth annual meeting, March 5-7.

PENNSYLVANIA SECTION—NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, meeting in Philadelphia, March 8.

NEW YORK SECTION, American Water Works Association, spring meeting, Albany, March 21-22.

FLORIDA SECTION, American Water Works Association, West Palm Beach, March 27-30.

CANADIAN SECTION, American Water Works Association, London, Ont., March 27-29.

Personals

FORREST W. PARROTT has been elected president of the Central Branch of the Associated General Contractors. For the past 14 years Mr. Parrott has been secretary of the C. F. Lytle Construction Co., Sioux City, Iowa.

PROF. JOHN N. FINLAYSON, head of the department of civil engineering, University of Manitoba, has been elected president of the Association of Professional Engineers of the Province of Manitoba.

HUGH MILLER, PWA engineer for Missouri, has been transferred to the Washington Headquarters of the Public Works Administration. Mr. Miller was formerly dean of engineering at George Washington University.

W. C. BROWN is PWA engineer inspector on pipeline construction work being carried out by the San Francisco water department. From 1925 to 1933 Mr. Brown was chief engineer for the San Dieguito Irrigation District in San Diego County, Calif.

J. E. MACKIE, formerly district engineer for the National Lumber Manufacturers Association at Portland, Ore., has been appointed manager of the Western Red Cedar Lumber, Seattle, Wash. Mr. Mackie previously had been in charge of preparing the Pacific Coast Uniform Building Code for the Building Officials Conference at Long Beach, Calif.

G. C. WILLSON, formerly superintendent of construction of the Hardy Dam, in Michigan, and more recently connected with PWA projects in Virginia, is now superintendent of cofferdam construction for Mason-Walsh-Atkinson-Kier Co. on the Grand Coulee Dam, with headquarters at Mason City, Wash.

HARRY T. FLASHER, former assistant division engineer in the Ohio State highway department organization, has been named maintenance operating engineer. L. L. GRASLER, also a former assistant division engineer, has been named division engineer for Division No. 12. C. M. ANDERSON,

former division engineer, has been made chief engineer of maintenance. These changes in personnel have been effected by John Jaster, Jr., the new highway director of the state of Ohio.

Obituary

MILTON B. HURDIS, age 29, an engineer in the Rhode Island Department of Public Roads, died on Feb. 13.

FREDERICK P. DINKELBERG, structural engineer in Cincinnati and New York, associated with some of the early tall building design work in New York City, died in Chicago recently at the age of 76.

SOREN THEADOR KIELLAND, 81, executive engineer for many years of the Buffalo Creek railway, died at his home in Buffalo, Feb. 14. Mr. Kielland was born in Norway and graduated with honors from the College of Engineering, Gotenburg, Sweden. He came to this country after a career of railway construction in Scandinavia, Central Europe and South Africa.

R. O. WYNNE-ROBERTS, consulting engineer and member of the firm of Wynne-Roberts, Son & McLean, Toronto, Canada, died suddenly at his home in that city on Feb. 5. After early engineering work in England, Mr. Wynne-Roberts spent several years in South Africa, followed by several more years as a consulting engineer in England before coming to Canada in 1910. In 1924 the present firm was organized, specializing in the field of municipal and sanitary work.

PATRICK FLANIGAN, 81 years old, president of P. Flanigan & Sons, Inc., Baltimore, and well known contractor in that city, died Feb. 8 at his home. Born in Ireland, Mr. Flanigan came to this country at the age of 18, entered the contracting business in 1876 and organized the Flanigan company five years later. His sons were taken into the company and the name changed a number of years later.

EUGENE HUNTER COLEMAN, consulting engineer, associated with his father John F. Coleman, in the engineering firm of the J. F. Coleman Engineering Co., New Orleans, died Feb. 12 at the age of 43. Mr. Coleman was born in New Orleans in 1891, graduating from Tulane University in civil engineering in 1911. Following a year's graduate work at Cornell University, he joined the engineering department of the Illinois Central Railroad, leaving that work to become associated with his father's firm. During the war he served as captain with the 312th Engineers in France.

WILLIAM J. FICHTER, vice-president of the Taylor-Fichter Steel Construction Co., New York, the company holding the contract of tower erection on the Triborough bridge, died Feb. 8 at Tonawanda, N. Y., at the age of 53. Mr. Fichter was on one of his frequent trips between New York and a bridge construction job which the company had under way on the Niagara River. His first construction experience was with the New York Central Railroad where he was particularly interested in railroad bridge work. Twenty years ago he helped to organize the company with which he was associated up to the time of his death.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING awards are lower on a holiday week following a holiday week. The total for this week is $10,896,000 which represents $2,309,000 in private work and $8,587,000 in public awards of which $1,530,000 is federal and $7,057,000 is state and municipal. The latter volume is higher than the low volume of municipal awards last week.

Highway awards at $3,767,000 are higher than last week; waterworks at $1,171,000 are higher; commercial buildings at $1,101,000 are higher but other classes of work fall below last week's volume of awards.

The larger awards for the week include: tuberculosis hospital for Lucas Co., Toledo, Ohio, $500,000; highway awards, $345,000 by Georgia, $371,000 by Virginia; laying pipe line, 10,771 lin.ft. steel and 34,091 lin.ft. reinforced concrete pipe, Tacoma, Wash., $651,000; Clendenning Dam, Tippecanoe, Ohio, $292,000; and cemetery development, White Chapel Memorial Park Corp., Buffalo, N. Y., $500,000.

New capital is up $7,777,000 due to PWA allotments totalling $5,207,000 and state and municipal bond sales totalling $2,570,000. The bond market continues strong.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Prev. 4 Weeks	Week Feb. 21 1935
	Feb. 1934	
Federal Government	$10,091	$4,007	$1,530
State and municipal	12,311	10,069	7,057
Total public	$22,402	$14,076	$8,587
Total private	3,663	7,086	2,309
Week's total	$26,065	$21,162	$10,896
Cumulative to date:			
1934...$237,000,000	1935...$193,591,000		

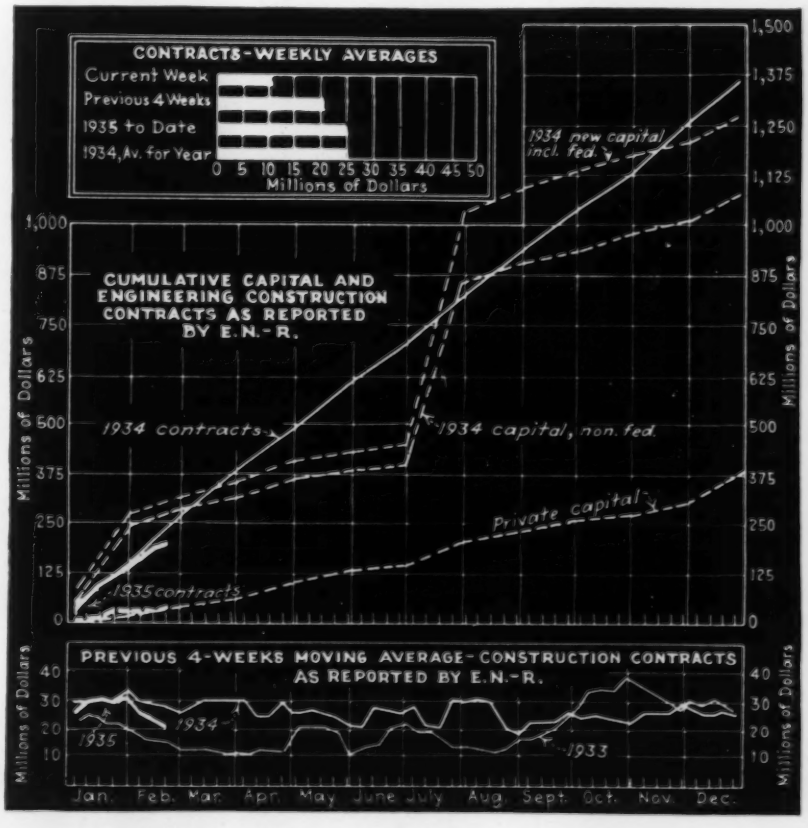
NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

1935	Week Feb. 21	Cumulative
State and municipal	$2,570	$52,359
PWA allotment, S&M	5,193	—24,415
RFC loans, S&M	.....	63
Corporate issues	.....	.....
PWA allotments, private	14	3,960
Total, Non-Federal	$7,777	$31,967
PWA allotments, Federal Constr.	.....	6,505
Total new capital	7,777	$38,472
Cumulative to date:		
1934...$312,099,000	1935...$38,472,000	

INDEX NUMBER

E.N.-R. Cost	1913 = 100	1926 = 100	E.N.-R. Volume	1913 = 100	1926 = 100
Feb., 1935	196.02	94.22	Jan., 1935	130	57
Jan., 1934	198.72	95.52	Dec., 1934	105	46
Feb., 1934	194.06	93.20	Jan., 1934	149	65
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56



Construction Equipment and Materials

Tripod Shoes Prevent Slipping

A tripod base for surveying intsruments or camera for use when it is necessary to set a tripod up on hard, slippery or irregular surfaces, has been announced

Tripod base in use on a slippery cement floor

by the Surgical-Mechanical-Research, Los Angeles, Calif. The device consists of three aluminum shoes, tied together by a heavy cord which is adjustable in length. Each shoe is provided with a corrugated rubber base.

New Black-Top Paver Is Self-Propelled

A self-propelling black-top paver has been announced by the Jaeger Machine Co., Columbus, Ohio. It is telescopic and adjustable for 9 to 15 ft. widths and handles from 400 to 1,000 tons of material per day.

Paving material is received in a hopper from a dump truck which the paver pushes forward at the speed with which the spreader screw distributes the material. The machine itself has 18-ft.-long straight-edge runners which are movable forms. They are full floating and carry the screed only, all other weight of the machine and road material being carried on four rubber-tired wheels. No weight or traction is on the new road surface as the runners and wheels operate on the old road or subgrade, and only the screed and blender screeds at the rear touch the newly laid material.

New Jaeger self-propelled black-top paver

The telescopic frame permits width adjustments from less than 9 ft. to 15 ft. by addition of change parts. Blender screeds at the rear of both runners adjust laterally for spreading bled-back material any additional width up to 12 in. on either side. The machine has the ability to lay a 15-ft. strip, making possible a 30-ft. road in two sections with only one joint.

New Equipment in Brief

Vehicle Stop. The Auto-Stop, newly announced by the Evans Products Co., is a vehicle-stopping device consisting of triangular sections which form a horizontal barrier when raised above the pavement. It is designed for the protection of railroad grade crossings. The sections are constructed of steel with a concave surface and are studded with reflector bulbs forming the word "stop." The device rises automatically from the pavement at the approach of a railroad train.

Carbide Light. A new carbide emergency light weighing only 40 lb. when fully charged and which burns for three hours, giving 800 candle power, has recently been announced by the National Carbide Sales Corp., New York, N. Y. Announced as a police emergency light, the manufacturer states that it has many other applications in the municipal, aviation, railroad and construction field.

Quick Setting Cement. Technical Products Co., Pittsburgh, Pa., announces Sauer-Eisen acid-proof cement No. 21, which will harden by setting within 36 hours. It is a white powder of high silica content and it achieves its initial set in about one hour. It is resistant to the action of water, oil, hot and cold acid.

Portable Pump. The Little Gusher portable pump, which features compact design, is announced by the L. R. H. Labaw & Co., Inc., Belle Mead, N. J. The pump is driven by a single-cylinder gasoline motor, direct-connected. It is made in two sizes: 1 hp., 7,000 gal. per hr., weighing 80 lb.; 3 hp., 15,000 gal. per hr., 160 lb., all rated at 20-ft. head.

Vibrating Screen.. The Robins Conveying Belt Co., New York, N. Y., announces the Vibrex screen for the accurate sizing of fine materials. It has uniform motion, easy angle adjustment, belt-absorbed vibration, and a construction which permits mounting on horizontal or inclined supports, or by cable suspension.

Plywood. The Harbor Plywood Corp., Hoquiam, Wash., has announced a new type of plywood characterized by its high resistance to moisture. In the fabrication of the panels a resin glue is used, which is applied dry between alternate plies. The manufacturer states that the new material is ready for use in from 3 to 5 minutes. Exposure and boiling tests indicate it can be used for outdoor purposes with no separation of plies and without warping.

Blueprint Machine. A blueprint machine utilizing the new Angstrom blueprint lamp has been placed on the market by Milligan & Wright Co., 4701 Prospect Ave., Cleveland, Ohio. The machine is of the portable table type and will print to a size of 18x24 in. An automatic time switch controls the length of exposure. The Angstrom lamp used is of the incandescent type, the light from which is stronger in the blue end of the spectrum.

Grader. Foote Bros. Gear & Machine Co., Road Machinery Division, Joliet, Ill., announces their new model "40" Stockland grader for operation with small tractors of 10 to 20 hp. on maintenance and side road reshaping work. It has a 7- or 8-ft. moldboard and weighs about 3,200 lb. A feature of the machine is that the controls may be changed from the rear to the front of the grader so that it can be operated by the tractor driver.

Personals

CATERPILLAR TRACTOR CO., Peoria, Ill., announces that C. Parker Holt has been named executive vice-president. Thomas J. Conner has been made vice-president in charge of manufacturing.

TYSON ROLLER BEARING CORP., Massillon, Ohio, announces that Charles E. Stuart has resigned as president and treasurer and has been succeeded by Mr. Russell E. Colgate.

New Publications

INTEGRITY OF FINISHES, Bakelite Corporation, Bound Brook, N. J. 6x9, 16 pages.

THE WHITTEMORE STRAIN GAUGE, Baldwin-Southwark Corp., Philadelphia, Pa. 8½x11, 6 pages.

DEFOREST SCRATCH RECORDING STRAIN GAUGE, Baldwin-Southwark Corp., Philadelphia, Pa. 8½x11, 4 pages.

CARPENTER TORSION IMPACT TESTING MACHINE, Baldwin-Southwark Corp., Philadelphia, Pa. 8½x11, 6 pages.

WESTERN ROLL CRUSHER, Austin Western Road Machinery Co., Aurora, Ill. 8½x11, 4 pages.

CATERPILLAR DIESEL POWER UNITS, Caterpillar Tractor Co., Peoria, Ill. 8½x11, 24 pages.

FAIRBANKS RENEWABLE GATE VALVES, Fairbanks Co., New York, N. Y. 6x9, 6 pages.

GALION MOTOR CONTROL GRADER, Galion Iron Works & Mfg. Co., Galion, Ohio. 8½x11, 24 pages.

AIR CUSHION VALVE COMPRESSORS, Pennsylvania Pump & Compressor Co., Easton, Pa. 8½x11, 12 pages.

BUILT-TOGETHER MOTOR PUMP UNIT, Fairbanks-Morse & Co., Chicago, Ill. 8½x11.

SUCCESSFUL EXPERIENCES. Cutler-Hammer, Inc., Milwaukee, Wis. 8½x11, 12 pages. Electrical valve-control apparatus for water and sewage plants.